THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1924

VOL. XLIX

WITH SIXTY PLATES

and 203 Text-figures.

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PART V. (No. 199).

(Issued 18th February, 1925.)

LIST OF NEW ORDINAL, FAMILY AND GENERIC NAMES PROPOSED IN THIS VOLUME (1924).

NEW GENERA OF MOLLUSCA PROPOSED IN THIS VOLUME.

CORRIGENDA.

Page 34, line 25, *for* Bendin *read* Baudin

Page 104, 7th line from bottom, *for* locis gramineis *read* sylvis

Page 105, line 7, *delete* "in grassy places"

Page 105, lines 9, 10, after Type), *read* Forest Reserve, Packakariki, Whakatikei'

Page 108, 8 lines from bottom; and page 110, line 10, *for* Cleland *read* Cleland and Cheel

Page 151, for *Helix aspera* read *H. aspersa*

Page 261, line 29, *for* 92 *read* 62

Page 347, line 9, for *larvei* read *laruei*

LIST OF PLATES.

PROCEEDINGS, 1924.

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, 26TH MARCH, 1924.

The Forty-ninth Annual General Meeting, together with the Ordinary Monthly Meeting, was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, 26th March, 1924.

ANNUAL GENERAL MEETING.

Mr. A. F. Basset Hull, President, in the Chair.

The Minutes of the preceding Annual General Meeting (28th March, 1923) were read and confirmed.

PRESIDENTIAL ADDRESS.

Perhaps the most outstanding scientific event in Australia during the year was the second meeting of the Pan-Pacific Science Congress. The first meeting of this Congress was held at Honolulu in 1920, and the second meeting was held under the auspices of the Australian National Research Council, partly in Melbourne and partly in Sydney. It was attended by more than 80 scientists from overseas, as well as by a large number of Australian scientists and others interested in the objects of the Congress. The holding of the meeting was made possible by the generosity of the Commonwealth and State Governments, and the work of organising and carrying out the meeting was performed by the executive of the Australian National Research Council. The meeting was most successful and we may look forward with interest to the publication of the papers read in the various sections.

Mention was made in the Presidential Address last year of the advantages that would result, both to members and to the Society, if the Society's headquarters could be removed to a more central position than Elizabeth Bay. During the year, the attention of the Council was given to this question, and as a result a property known as Lauriston Hall, 16 College Street, overlooking Hyde Park, was purchased by the Society. The property was bought subject to an existing lease expiring in February, 1925. The tenant has, however, asked to be released

and the Council has agreed to allow her to vacate the premises. As a result, alterations to the property will be commenced immediately, and on their completion the Council has decided to remove the office of the Society to 16 College Street, where the ordinary meetings will be held. The request came from our tenant quite unexpectedly and the Council had to come to a decision at once; it was therefore decided to allow the library to remain at Elizabeth Bay for the present, until the Council is able to consider carefully all the matters connected with a complete removal of the Society's activities to the new site. We hope to hold our first ordinary meeting at the new address about the middle of the year. We will thus give effect to the aspirations of your Council as expressed by my predecessor in this chair in his presidential address last year, and at a date, I may venture to say, far in advance of his most sanguine anticipations.

The community suffered a severe loss by the death, in September last, of the State Governor, Sir Walter Davidson. His Excellency showed a keen appreciation of the work of this and other scientific societies and was especially interested in a scheme to bring all such societies under one roof.

Several years ago I entertained a hope that the two leading scientific societies might be induced to join forces in devising a scheme for the establishment of a comprehensive Science Building; options on sites were secured, but in view of the disturbed condition of affairs during the war, the project was allowed to lapse. Shortly after my election to the presidency of this Society I again took the matter up, and on the occasion of my official call upon the Governor, I referred to the subject, only to find that His Excellency had independently conceived a similar plan in conjunction with the proposed Soldiers' Memorial and the extension of the Mitchell Library. At His Excellency's invitation I joined the committee which was engaged with him in elaborating his plans. At the same time I brought the subject before your Council, and it received a considerable amount of attention during the year. The lamented death of His Excellency abruptly terminated the proceedings, but I personally may be permitted to express the hope that means will yet be found to carry the scheme of union of the Scientific Societies to a successful conclusion. The central feature of my plan is a large Hall of Science, erected on a commanding site in the city, with annexes providing lecture rooms, office accommodation, libraries, committee rooms and every accessory of a well-equipped club; an Institution such as would be a credit to this great city, and a meeting place for the leaders of science, literature, art and philosophy; erected by the joint efforts of every association formed for the furtherance of such objects; managed by a joint committee; but so constructed and laid out that each Society would retain its own individuality unimpaired; its own distinctive quarters, with, at the same time, the advantage of co-operative performance of those details of house management which would be for the common use of all members. The ideal is a high one, but by no means unattainable, if those who guide the destinies of our great societies could agree to work together for the common good of themselves and their humbler brethren.

The concluding Part of Volume xlviii. of the Society's Proceedings has been issued. The complete volume (688 + lxxxii. pages, 52 Plates and 438 Text-figures) contains forty papers, covering a wide range of subjects in Natural History, nine papers being contributed by the Society's research staff.

Exchange-relations with other scientific societies and institutions are now more normal, the receipts for the session numbering 1,450. During the past year we have resumed exchanges with a number of German Scientific Societies with

whom we exchanged formerly, and have added to the societies and institutions on our exchange list the following:—Bergens Museum, Bombay Natural History Society, Botanisches Museum zu Berlin-Dahlem, Liverpool School of Tropical Medicine, National Research Council of Japan, Notgemeinschaft der deutschen Wissenschaft, Société botanique de Pologne and Société d'histoire naturelle de Toulouse. Bookbinding operations are proceeding steadily, the publications most used by members receiving first consideration.

Last year there seemed a likelihood that the issue of the "Zoological Record" might be discontinued. The difficulty, one of finance, appears to have been overcome and it is now assured that the volume for 1921 will be issued and that for 1922 will be prepared. Following the lead of the Academy of Natural Sciences of Philadelphia, your Council has offered to contribute towards any loss on the publication of the Record in the year ending 30th June, 1924, and to consider further contribution, should such be necessary, in succeeding years.

In response to a request from the N.S.W. Exhibition Commission the Council agreed to prepare an exhibit of the Society's publications for the Education Section of the British Empire Exhibition.

Mr. A. H. S. Lucas, having accepted the Acting-Professorship of Mathematics in the University of Tasmania for the year 1924, decided not to seek re-election as a member of the Council of the Society. I desire to place on record our appreciation of the valuable services rendered to the Society by Mr. Lucas as a Member of Council for twenty-nine years, during two of which he occupied the presidential chair.

Mr. W. W. Froggatt, a member of Council since 1898, retired during the year from the position of Government Entomologist. His services as an economic entomologist have, however, not been lost to the State, as he has been appointed Forest Entomologist to the Minister for Lands and Forests, his work being to study the pests of timbers in the forests, and also the pests coming into this State from abroad in imported timbers.

After thirty-three years of service on the staff of the Australian Museum, Mr. Charles Hedley has retired under the provisions of the Superannuation Act. Although he has still some years to traverse before reaching the compulsory retiring age, he has exercised his option and voluntarily relinquished his position as Principal Keeper of Collections in that Institution. While we cannot but regret the severe loss that must result to the scientific side of the Museum, it is a matter for sincere congratulation that Mr. Hedley's high attainments have been substantially recognised by the neighbouring State of Queensland, he having been appointed scientific director of the Great Barrier Reef Committee, a most important body formed under the auspices of the Royal Geographical Society of Australasia, Queensland branch, to engage upon research problems in relation to that great natural feature of the Queensland coast. To us personally and as members of the local scientific bodies, Mr. Hedley's removal from this State for the greater part of the year will be fraught with the sincerest regret. His well-considered judgment and ever helpful counsel in the scientific and business conduct of our Societies, in all of which he has been an esteemed office bearer, will be sorely missed. Our chief consolation lies in the fact that in his new sphere of activity he will be enabled to add more lustre to his already great achievements in the world of scientific effort. We also have to offer Mr. Hedley our hearty congratulations on the honour conferred upon him by the New Zealand Institute, which has elected him an Honorary Fellow.

I have much pleasure in offering the Society's heartiest congratulations to Mr. W. B. Gurney on his appointment as Government Entomologist; Sir Douglas

Mawson on his election as a Fellow of the Royal Society of London; Mr. A. H. S. Lucas on his appointment as Acting-Professor of Mathematics in the University of Tasmania.

The reading of papers at the ordinary meetings has again been supplemented by discussions and lecturettes, and we are indebted to Miss M. I. Collins, Dr. C. Anderson, and Messrs. A. R. McCulloch and D. G. Stead for short lantern lectures.

Since the last Annual Meeting the names of 14 ordinary members have been added to the roll, 4 members have resigned and we have lost by death one corresponding and two ordinary members. This leaves the Society with 166 ordinary members on the roll.

Achile Raffray, Ministre plenipotentiaire de France, en retraite, died at Rome, 24th September, 1923, at the age of 79. He had been a corresponding member of the Society since 21st November, 1900. By his death entomology has lost one of its most distinguished workers, M. Raffray being the world's authority on the Pselaphidae. The publication of his last work "Sur la dispersion geographique des Psélaphiens du Monde" has commenced in the "Memorie dell'Accademia Pontificia dei Nuovi Lincei." He contributed an important paper on Australian Pselaphidae in our Proceedings for 1900.

HENRY DEANE, who died at Malvern, Victoria, on 12th March, 1924, was born at Clapham, London, in 1847 and was educated at Queen's College, Galway and King's College, London.

He was the son of Henry Deane (1807-1874) of Clapham, a noted pharmaceutical chemist, the first President of the British Pharmaceutical Conference and a Fellow of the Linnean Society of London from 1855 till his death. Amongst the schoolfellows of Henry Deane, Senior, were Henry and Edwin Doubleday, afterwards the distinguished entomologists, who communicated their love of collecting birds and insects to Mr. Deane, whose interest in natural history, thus aroused, never waned. He was a personal friend of A. R. Wallace and others of the same time and received from Dr. Harvey (who visited Australia to collect seaweeds, wrote a book on them and distributed sets of seaweeds) a set which Henry Deane, Junior, inherited. This set he presented, together with his own private herbarium, chiefly of New South Wales plants, to the National Herbarium in Sydney only some four years ago.

Thus it was the example and influence of his father that aroused the interest in natural history of the Henry Deane whose loss we mourn. Before he came to Australia, he collected and studied British insects, but in Australia, in his leisure hours, he specialised in botany.

For the greater part of his life Henry Deane was connected with railway engineering. Before coming to Australia in 1880, he had been engaged first with the London metropolitan railways and later in Hungary and the Philippine Islands. From 1880 to 1906 he was employed in the construction department of the New South Wales railways, rising to the position of Engineer-in-Chief, and being associated with many important railway works, including the construction of the bridge over the Hawkesbury River and the introduction of the electric tramway system in Sydney.

In 1908, two years after retiring from the service of the New South Wales railways, Mr. Deane was appointed by the Commonwealth as controlling and consulting engineer in connection with the survey of the proposed transcontinental railway between Kalgoorlie and Port Augusta, and later, as Engineer-in-Chief of the Commonwealth railway construction branch, he did much towards bringing to a successful conclusion the task of building this 1,100-mile line of railway

through an almost waterless and uninhabited region. In 1914 he severed his connection with the Commonwealth railways and practised as a consulting engineer in Melbourne.

Mr. Deane became a member of this Society in 1883, and, until his removal to Melbourne, was a very active member of the Society, being a regular attendant at the meetings and a frequent exhibitor of interesting specimens. He was a member of Council from 1887 to 1912 and was President for the years 1895-96 and 1896-97.

He was a member of the Royal Society of New South Wales from 1885 till his death, and occupied the presidential chair of that Society on two occasions (1897 and 1907); he was elected a Fellow of the Linnean Society of London in 1885.

During the years 1895-1901 he contributed fourteen papers, nine of them in conjunction with Mr. J. H. Maiden, to the Proceedings, amongst them being a series of eight papers containing observations on the Eucalypts of New South Wales. Before the appointment of Mr. Maiden to the Botanic Gardens, he was in close touch with such eminent botanists as Dr. Woolls, Mr. Fitzgerald and Baron von Mueller. He was an accomplished botanist, and, apart from his work on present day plants, he had carried out much work on the Tertiary fossil flora of Eastern Australia—a most difficult subject to deal with satisfactorily. Some of the results of these fossil studies were published by the Geological Survey of New South Wales, and they form a valuable contribution to our knowledge of the flora which preceded the existing flora in Australia.

Although living in Melbourne for the last twelve years, he retained his interest in the Society and its doings and it was rarely that he did not find time, on his visits to Sydney, to look in at the Society's headquarters. His death removes one who took a keen interest in the Society's affairs and who helped to guide the destinies of the Society for a quarter of a century.

How similar was the end of the father to that of the son! Of Henry Deane, Senior, we read: (Proc. Linn. Soc. Lond., 1873-74, p. xlix.) "The death of Mr. Deane occurred on the 4th of April, 1874, at Dover, where he had been detained for a day or two by stress of weather on his way to visit his son in Hungary. Walking from his hotel to the boat he was attacked by sudden pain in the region of the heart, and in a few minutes had ceased to exist." Of Henry Deane, we learn that he collapsed suddenly while working in his garden and passed away without regaining consciousness.

Jacob Robert L. Dixon, who died on 27th October, 1923, after an illness extending over several months, was born at Liverpool, England, in October, 1861. He was educated at the Royal Infirmary Medical School, Liverpool and obtained his L.R.C.P. of Edinburgh and M.R.C.S., England, in 1884. He was for a time Honorary Pathologist to the Royal Southern Hospital, Liverpool, and then entered into private practice in the South of England. He came to Australia in 1912 and, very shortly after his arrival, was appointed Demonstrator in Physiology, and later, in 1923, Lecturer in Histology at the University of Sydney. Dr. Dixon joined the Society in 1913 and for a number of years was a regular attendant at our meetings. He was keenly interested in Natural History, particularly microscopy and conchology, and paid a good deal of attention to a group of small Crustaceans found infesting the masses of seaweed and bryozoa round the piles of wharves and floating jetties. He was also an artist of no mean ability and was passionately fond of water colour landscapes. He was a very reserved man and few of his colleagues knew much of his hobbies.

Last year attention was called to the possibility that, as a result of visiting expeditions of collectors to Australia, the best collections of some groups of Australian animals would be found, in the near future, not in Australian Museums, but in those outside Australia. As a result of representations made to him the Prime Minister has intimated that it is intended to grant permits in future to expeditions engaged in collecting specimens in Australia only on condition that types of any new species and duplicates (one pair in each case) of any rare species are donated to the Museum in the State in which specimens are collected. This is a very satisfactory arrangement in view of the need for future research workers to have material for comparison.

During the year the Minister for Trade and Customs has appointed advisory committees in the various States to assist him in connection with applications which may be received for permission to export prohibited Australian birds and animals. Applications will be submitted to the Advisory Committee in the State concerned and on receipt of the Committee's recommendation the Minister will decide whether or not each application shall be granted. The committees consist of representatives of various institutions and in each case a deputy has been appointed to act in the absence of the representative. The New South Wales Committee comprises Professor L. Harrison (deputy, Dr. A. B. Walkom) representing The University of Sydney, Royal Society of N.S.W. and Linnean Society of N.S.W., Mr. F. Flowers (deputy, Col. A. Spain) representing the Taronga Zoological Park Trust, Mr. A. F. Basset Hull (deputy, Mr. A. R. McCulloch) representing the Royal Zoological Society of N.S.W., Dr. C. Anderson (deputies, Mr. E. le G. Troughton, and Mr. J. R. Kinghorn) representing the Australian Museum, Mr. W. W. Froggatt (deputy, Mr. E. Cheel) representing the Naturalists' Society of N.S.W. and the Wild Life Preservation Society of N.S.W., Mr. N. Cayley (deputy, Mr. J. S. P. Ramsay) representing the Royal Australasian Ornithologists' Union (N.S.W. Branch), Mr. F. Farnell (deputy, Mr. W. F. L. Bailey) representing the National Park Trust and Mr. F. Lynne Rolin (deputy, Mr. S. T. D. Symons) representing the Royal Society for the Prevention of Cruelty to Animals. The issue of permits to export is subject to the requisite permission being obtained from the State Government to collect the Birds and Animals concerned.

The announced intention of the Government to introduce a Bill to provide for representation of the Scientific Societies on the various Park Trusts was not carried out during last Session, but recent paragraphs in the daily press indicate that the subject has not been entirely lost sight of.

This Society joined with others interested in the preservation of our native fauna in a deputation which waited upon the Chief Secretary in June last. In the absence of Mr. Oakes the deputation was received by Mr. Farrar, and a reply to the representations then made has been recently received. While in some details improvements are being introduced in the administration of the Act, there still remains much to be done, but the all-important question of finance seems to block the way to a more stringent enforcement of the provisions of the Statute.

The Australian Forest League which has been formed recently should play an important part in the preservation of our forests. It may be said to stand in the same relation to our trees as does the League of Bird Lovers to our birds. Among the objects of the Forest League are:—The Maintenance and preservation intact of the present forests; Re-afforestation of denuded areas; Tree Planting of waste spaces and sand dunes; Protection of forests against fire and other des-

tructive agents; To foster the planting of trees for shelter and ornamental purposes; To advertise the value and encourage the use of our timbers and their products; Publication and diffusion of facts and statistics concerning our trees and forests; Education of the public to a realisation of the value of our forests; and Protection of our indigenous flora and fauna.

We may wish this organisation every success.

The year's work of the Society's research staff may be summarised thus:—

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, has continued the investigation into the activities of the high-temperature organism used in the corrosion of lead.

Three papers have been submitted and have been published in the Proceedings during the year. These showed that the characteristic substance of the tan-bark, after undergoing the process of tempering, is humic acid which is readily fermented by the thermophilic bacterium. Tempering is a preparatory fermentation in which moulds attack the insoluble cellulose and convert it into simpler bodies. Some of the moulds were isolated and seeded upon filter paper. They converted the paper into a product which readily yielded carbon dioxide upon the introduction of the high temperature organism. The bacterium can attack many compounds of carbon such as sugars, alcohols and organic acids while ammonium salts and urea can serve as sources of nitrogen. Raffinose and inulin among the carbohydrates, and oxalic and formic among the acids were not attacked.

The bacillus is sensitive to sudden changes of temperature and its inability to ferment solutions of citrate was traced to the organism being chilled when distributed in fluid at the laboratory temperature.

Some work has been done with bacteria isolated from the nodules at the bases of the stems of Eucalyptus seedlings. Only one out of many bacteria has given positive evidence of nodule formation but, as the results may have been accidental, much work has yet to be done before a definite conclusion can be made.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Bio-chemistry, has, during the past year, continued his investigation of the colour pigments of Acacia flowers. In addition to the two species (*Acacia discolor* and *A. linifolia*) already dealt with, work has been carried out with *A. mollissima* and *A. longifolia*. From all four species the pigment proved to be the same, having the constitution of Kaempferol, in union with the sugar rhamnose as a glucoside. Closely associated with this glucoside are certain organic acids and phenols which evidently play a part in the formation of the yellow pigment and of the red colouring matter and tannins. The results of these researches are contained in the paper "Studies in Plant Pigments, I.," published in Part 3 of the Proceedings for 1923. Further investigations have been commenced, with *Eucalyptus stricta* and *E. eugenioides*. Plants of the former were observed whose foliage and small twigs were changed from green to red, the change being the result of insect injury. An attempt was made to obtain from these plants and from healthy normal flowers of the same species both the yellow and red pigments in order to determine whether the two are chemically related. This research was obstructed by the separation of a highly insoluble white compound which has now been isolated in a practically pure condition. The red leaves proved to contain no anthocyanins, the pigment being a tannin red formed by oxidation of the catechol tannins in the normal leaves. These red leaves and twigs are therefore in contrast with the young spring growth which contains true anthocyanins.

Dr. Petrie proposes, during the coming year, to continue his work on various species of *Eucalyptus;* also on the flowers of *Erythrina* for the red pigment; and on certain Acacias for the red pigment of the flowers and its relationship with the yellow pigment already obtained.

Miss Marjorie I. Collins, Linnean Macleay Fellow of the Society in Botany. has spent a good part of the year in preparing the results of her field work for publication. The first paper, dealing with the plant ecology of the Barrier district, appeared in Part 3 of the Proceedings for 1923 and the second paper, dealing with the botanical features of the Grey Range and its neighbourhood is complete and ready for publication.

Additional field work was carried out in the Cobar district and on the Darling and Paroo Rivers after the autumn and winter rains, and observations were made on the winter herbage. These supplemented previous observations which had been restricted to the ground flora following spring and summer rains. An examination was also made of the red soil scrub floras between the Paroo and Warrego Rivers and between the Warrego and Darling. During this field-work Miss Collins collected what is probably a new species of the rare aquatic liverwort *Riella* which genus has not previously been found in Australia. The occurrence of an aquatic liverwort in a region subject to rainless periods extending over years is one, the study of which promises to be of very great interest.

Miss Collins proposes, during the coming year, to complete her ecological studies of the vegetation of the arid and semiarid regions of New South Wales, visiting, for that purpose, the lower part of the Darling near its junction with the Murray; she also proposes to make a study of the vegetation of the serpentine deposits of New South Wales.

Miss Marguerite Henry, Linnean Macleay Fellow of the Society in Zoology, in continuation of her studies of the freshwater entomostraca of New South Wales, completed her account of the Ostracoda, the results being published in Part 3 of the Proceedings for 1923. Whilst studying the Phyllopoda, Miss Henry visited the Cobar district for the purpose of studying the occurrence and habits of living Phyllopods, as this group is far more abundant in western New South Wales than in the coastal region. The description of this group has now been completed and the results are ready for publication. Nineteen species are dealt with, six of them being described as new, and three recorded for the first time from New South Wales. Miss Henry has been working also on samples of dried mud from Queensland and Central Australia, and on a collection made by Mr. T. Steel from New Zealand lakes.

Miss Henry completes her work as a Linnean Macleay Fellow on the 31st instant, and leaves on the 12th April on a holiday trip to England. We may express our satisfaction with the results of her work as a Fellow, and wish her a very pleasant and enjoyable trip.

Dr. Walkom has completed two pieces of work on fossil plants during the year, viz. (1) a description of a collection of plants of Upper Triassic age from Bellevue, Queensland, forwarded by the Director of the Queensland Museum and (2) the examination of the collection of fossil plants from the Narrabeen series for the Geological Survey of N.S.W. Arrangements have now been completed for him to receive for examination collections of Mesozoic plants from the Geological Survey of Tasmania. The description of these Tasmanian specimens should add considerably to our knowledge of the distribution and relationships of Australian Mesozoic floras and may well help to clear up some of the doubtful

points in connection with the correlation of the freshwater Mesozoic Strata of Tasmania and the mainland.

Five applications for Linnean Macleay Fellowships, 1924-25, were received in response to the Council's invitation of 26th September, 1923. I have pleasure in reminding you that the Council has re-appointed Dr. J. M. Petrie and Miss Marjorie I. Collins to Fellowships in Bio-chemistry and Botany respectively for one year from 1st April, 1924, and has appointed Miss May M. Williams, B.Sc., and Mr. P. D. F. Murray, B.Sc., to Fellowships in Botany and Zoology respectively for one year from 1st March, 1924. Mr. Murray, who desired to take his degree at Oxford, will not commence his Fellowship till 25th April. On behalf of the Society I wish them a successful year's research.

Miss May Marston Williams graduated in Science in 1921 with First Class Honours and medal in Botany, and for two years has held a Science Research Scholarship in Botany. Since graduation her research work has resulted in the completion of two papers, "A Contribution to our knowledge of the Fucaceae" and "The anatomy of *Cheilanthes tenuifolia* (Swartz)." The former appeared in Part 4 of our Proceedings for 1923 and dealt with the branching, oogenesis and parasitism of *Notheia anomala* and the oogenesis and spermatogenesis of *Phyllospora comosa*. In addition Miss Williams has been working on the anatomy of some Australian Pteridophyta. She proposes for her year's work as a Fellow to study the life histories, morphology and physiology of the Australian siphonaceous algae.

Mr. Patrick Desmond Fitzgerald Murray has already shown great promise as a research zoologist. He graduated in science at the University of Sydney in 1921 with First Class Honours and Medal in Zoology and First Class Honours in Botany, gaining the John Coutts Scholarship for distinction in Science in 1922. Since graduation he has spent two years working at Oxford under Professor Goodrich and Mr. Julian Huxley and has done vacation work at Edinburgh and at the Marine Biological Station at Plymouth. He has worked with Mr. Huxley on the effects of grafting certain tissues on to the membranes of the embryonic chick and proposes for his year's work as a Fellow to study the reaction of tissues to the presence within them of various foreign bodies, more especially other tissues, with special reference to the problem of Metaplasia.

THE RELATION OF THE LORICATES TO THE COUNTRY ROCK.

(Plates i.-iii.)

One very hot day in the summer of 1906 I was surfing at Freshwater Beach, north of Manly. Towards midday the tide had fallen to such an extent that it was possible to wade round the rocks at the northern end almost to the point. The numerous rock-pools, filled with translucent water through which the brilliant colouring of the marine growths could be seen, offered such an attraction that I spent some time in them, turning over the loose stones and examining the mollusks, crustacea and echinoderms sheltering beneath them. I was struck with the number and variety of the Loricates * or Chitons, a group with which I was not at all familiar, and impelled by the collecting instinct I gathered examples of each easily recognisable species, subsequently removing the animals and roughly preparing the shells by placing them between two flat pieces of wood under a heavy weight. This collection I submitted to my friend Charles Hedley, who identified

* Iredale and I have shown (Aust. Zool., iii., 1923, 186) that, according to the law of priority Gray's ordinal name Polyplacophora (1821) used by Pilsbry (1892) and other writers, must be rejected in favour of Schumacher's Loricata (1817).

no less than seventeen species with two varieties, including some rather scarce species. Interest being thus aroused in the group, I acted on Hedley's advice and commenced to collect these shells intensively within Port Jackson and on the ocean headlands in the vicinity. During the eighteen years that have since elapsed I have extended my field of observation to other parts of the coast of New South Wales, to Queensland from Brisbane to Townsville, to Western Australia from Albany to Esperance, and to King Island in Bass Strait.

In the course of my expeditions it soon became evident that there was some relation between the shells and the rock forming the littoral. One species, *Ischnochiton lentiginosus*, originally recorded from Newcastle, N.S.W., and subsequently taken by Dr. Cox at Port Hacking, should have been discoverable at the intermediate locality of Port Jackson, but I searched for it in vain. One day, when examining a rather unfavourable spot at the southern end of Deewhy Beach—unfavourable on account of the scattered nature of the boulders and the absence of sheltered pools—I found the sought-for species under loose shingle, partly embedded in sand near median tide mark. Just above where the shells were found there were loose friable shales and pipeclay through which a small creek flowed. These shells were all of pale brown to yellow shades, with the characteristic blue "freckles" from which the specific name is derived. A little later I found this species in large numbers at Long Reef, the Basin, Mona Vale and Newport (Bilgola Head). The iron dyke at Long Reef is a well known feature, and the shells from this locality showed another direction in which the influence of the rock was felt; they were mostly very dark in colour, being almost blackish-brown. Subsequent discoveries of this species on the shales of Bulli, the basalt near Port Kembla, the granite of Montagu Island, the porphyry of Port Stephens, Broughton Island, and Coff's Island, and the serpentine of Port Macquarie showed the predilection of the shell for the harder rocks and the dark coloured shales. Even at Port Hacking, where the rock is mainly sandstone, this species is found in abundance in the vicinity of dykes only. In each instance the influence of the rock on the general colour scheme of the shells is noticeable, the lighter coloured rocks yielding pale yellow and light brown shells, while those from the basalts, shales, ironstones and other darker coloured rocks are dark to blackish-brown, with frequent varieties showing white bars or patches on some of the valves.

This indication of some relation between the Loricates and the rocks was verified at each new locality examined on the coast of New South Wales. Apart from the occurrence of the species above referred to only in conjunction with certain rocks, a more important factor early became apparent. The relative numbers of species and individuals were found to show marked variation according to the nature of the rock. On the basalt of the Five Islands, near Port Kembla, both species and individuals were remarkably few in number. It is true that the exposed position of the rocks did not tend to encourage settlement, but even the hardy species, such as *Poneroplax paeteliana, Onithochiton quercinus* and *Sypharochiton pellis-serpentis*, so frequently met with on the outer rocks exposed to the full force of the surf in sandstone country, were absent or extremely rare on the basalt.

In 1907 I visited Montagu Island, about 150 miles south of Sydney. This Island is roughly in the form of a figure 8, the northern portion of basalt, and the southern of granite, the two being almost separated by a narrow gully through which the sea has been known to break in very heavy weather. I found no Loricates on the basalt, and there were not many on the granite. In the boat harbour *Ischnochiton lentiginosus* was plentiful, and *Poneroplax paeteliana* was found on

the rocks in small numbers. A very sheltered pool was searched thoroughly, and yielded a total of eight species belonging to seven genera. Of the four common species which are almost general on the coast of New South Wales—*Ischnochiton proteus*, *I. crispus*, *Ischnoradsia australis*, and *Heterozona fruticosa*—there were numerous examples, but the other three species in the pool were represented by single individuals only. The granite island therefore yielded ten species, seven being common and three rare. This was in the month of October, before the surface temperature of the water had reached summer level, and the upper littoral zone would therefore be most thickly populated.

I then communicated with one of my correspondents in South Australia, Mr. A. R. Riddle, who kindly sent me a list of the species of Loricates found in association with three kinds of rock in that State. Associated with magnesian travertine he had taken no less than 15 genera, comprising 36 species; with granite he found 5 genera and 7 species, while with calciferous ferruginous sandstone only one species was found. My own observations had resulted in locating 22 genera, comprising 33 species associated with the sandstone of Port Jackson and vicinity; seven genera and 8 species on the granite of Montagu Island, and three species on exposed basalt.

During 1910-11 I visited Port Stephens and the Islands (Cabbage Tree, Broughton, etc.) in the vicinity, but as I was primarily engaged in an investigation of the Petrels breeding there, very little time was available for collecting Loricates. However, a few hours spent on Fly Point in the Harbour, and on Broughton Island, disclosed a fairly large number of species and individuals in the more sheltered localities. No further opportunity for personally investigating this locality presenting itself, I have gladly taken advantage of the splendid results attained by Mr. A. E. J. Thackway, who spent three weeks in making a careful examination of about fifteen miles of the littoral within Port Stephens. He collected no less than 34 species, embracing 18 genera, and including all the species hitherto recorded from Port Jackson, with two or three exceptions. Mr. Thackway collected in September, one of the cold water months during which those species which seek a lower zone in the summer would be within wading reach. The rocks of the Port are chiefly granitic, and the wealth of the Loricate fauna appeared remarkable when compared with the comparatively scanty forms and individuals of Montagu Island. Reference to the geological map of Port Stephens and its vicinity will show that there are still large gaps to be examined in detail, but the feature that bears most upon the subject of this paper is the presence of a large area of Carboniferous sediments with tuffs, forming the littoral to the east of Nelson's Bay. Interbedded flows and dykes of andesite and porphyry are shown on the map, Point Stephens being wholly composed of andesite.

During the years 1912-16 I visited Bateman's Bay and the Tollgate Islands, Ulladulla and Brush Island, Port Kembla and the Five Islands, and in each case I was struck with the scanty nature of the Loricate fauna wherever the rock of the littoral was granitic, basaltic, dioritic, quartzitic or schistose, without any association of sandstones, shales or limestone.

During 1921-3 I paid three visits to Queensland during the winter months, collecting at a number of points from Southport to Townsville. The results of these trips may be briefly set out in the order of the localities visited, from south to north. At Southport the shore rocks are slates and quartzites, much altered and in places decomposed to ferruginous clays. Here I found not a Loricate of any kind. Incidentally, however, I may state that Professor T. Harvey Johnston

gave me some specimens of *Squamopleura curtisiana* Smith, which he had collected at Redcliffe at the entrance to the Brisbane River, where the formation consists of ferruginous clays and sandstones, with decomposed basalt in the vicinity. As there are sandstones about the islands off Southport I consider it quite probable that a more extended search will reveal a few Loricates in that locality. North of Brisbane the first rocks are found at Caloundra. Here the long sandy stretch of Bribie Island ends at the entrance to the Pumicestone Passage, and opposite the end of the Island lies Caloundra. Harvey Johnston (Queens. Nat., ii., 1917, 54) describes the locality as follows:—"There are two rocky headlands, Caloundra Head (or Wickham Point) and Moffat's Head, the latter being the more northerly. They are formed of a Trias-Jura (probably Jurassic) sandstone, sometimes fine grained, coarsely conglomeratic, and containing a considerable quantity of iron. Imbedded in the rocks are large trunks and branches of fossil conifers, whose wood has been replaced by limonite, while in a few places on the cliff face of Moffat's Head thin bands of coal and carbonaceous shale are to be seen." Some collecting had been done here by Iredale (1909), Harvey Johnston, and others. I spent five days collecting there in 1921 and 1922, examining both the south and the north headlands; the latter is higher and more generously furnished with sheltered rock pools than the former. The yield of Loricates amounted to 18 species of 14 genera, including two species I have since described, the remainder, with one exception (*Liolophura queenslandica* Pilsbry), being common to Port Jackson. Those two handsome members of the highly specialised genus *Rhyssoplax*, *R. vauclusensis* and *R. translucens*, which Hedley and I first described from Vaucluse, were taken in small quantity. About ten miles further north by sea (but quite a long way round by land!) is Point Cartwright at the entrance to the Mooloolah River. Here a high bluff has weathered on the northern side, forming a broken pavement with gutters filled with loose stones, ending in a series of escarpments behind which lie sheltered pools and scattered boulders. Four days were devoted to this locality, and the yield was similar to that of Caloundra; if any difference could be remarked it was in the greater number of individuals, due possibly to the less accessible locality and the greater extent of protected pools.

About half a mile further north, and on the northern side of the Mooloolah River, lies Alexandra Headland, another sandstone point, but less extensive, more ferruginous, and of a harder nature than that of Point Cartwright. My visits to this Headland were a brief one in July, when the tide was not very favourable, and one day in September, when the surface temperature had become higher. The results were not nearly so good as at Point Cartwright, although an August visit by a friend had resulted in quite a number of the species usually found in the upper zone. Ten miles north of Alexandra Headland lies Coolum Head, and beyond that for a further ten miles stretches Coolum Beach, terminating in the well-known Noosa Head, south of the entrance to the Tewantin River. I visited both of these Headlands, which consist of grano-diorite and schists—extremely hard, jagged masses, seamed and riven with deep clefts into which the surf tumbles violently even in moderate weather. There are, however, several deep rock pools with abundant algal growth and many loose stones suitable for the shelter of Loricates. Both Headlands were practically untenanted, except by the ubiquitous *Liolophura queenslandica*, which inhabited the less exposed crevices above median tide mark in countless numbers, nearly every specimen examined showing the effects of exposure in the erosion of the tegmentum. Whole days of exhaustive search in both localities resulted in my taking a single specimen of

Onithochiton quercinus and a couple of small examples of *Acanthochiton variabilis* on each Headland.

The next point visited was Burnett Heads near Bundaberg. Here the formation is basalt, and although some extensive boulder-strewn pools were examined the yield was limited to the common *Liolophura,* which was plentiful, and three diminutive specimens of *Acanthochiton.* Port Curtis was the next locality visited, a country of quartzites and schists, but with extensive muddy foreshores. This is the type locality of *Squamopleura curtisiana,* and that species was found in abundance, chiefly amongst the oysters on the piers of the wharf. Under a few stones scattered along the shore, and at Barney Point, south of the town of Gladstone, I found a considerable number of *Ischnochiton* (*Haploplax*) *arbutum* and *I. luticolens,* both apparently finding comfortable quarters and sufficient sustenance on the hard angular fragments of quartzite embedded in the viscous mangrove mud of the littoral. A day spent on Facing Island (northern end) yielded numerous examples of *Liolophura* and a few *Acanthopleura gemmata,* with three *Acanthochiton variabilis* nestling together in a crack in a piece of decomposed rock. The formation of this Island is quartzites and schists (phosphate-bearing) with granite at the south end, but I did not reach the granite portion. A raised coral reef, much weathered, is situated near the northern end on the seaward side. This reef was thickly populated by *Liolophura* only. Many hundreds of stones were diligently overturned in the course of the day's collecting, but there were no representatives of the family Ischnochitonidae to be found. The total from Port Curtis therefore amounted to five genera and six species, four being comparatively common.

Emu Park, in Keppel Bay, is the principal watering-place of Rockhampton. Here there is a rocky point of quartzite and schist, with a few sheltered rock pools, and a day's collecting yielded the same species as were found at Port Curtis, together with a new and beautiful species of *Rhyssoplax* to which I gave the name *venusta;* only three examples were taken. The conditions at Emu Park, as regards shelter, loose stones in pools, and abundance of algal growth, were all favourable to the harbourage of Loricates, but the results were only seven genera and species, two being rather plentiful and the others scanty as to individuals.

Two hundred miles further north, at Slade Point, Mackay, was my next collecting ground. On the northern and western sides of this point the coal measures have been disturbed by igneous intrusions. The headland is about ninety feet in height, and the cliff debris forms many sheltered pools, while a great sandbank, two to three hundred yards out, breaks the surf. The natural conditions of food and shelter were all that could be desired, but the yield, after many hours' patient search, was a total of four species, three of which were represented by single individuals!

Port Denison (Bowen) was next visited, a country of granitic and dioritic rocks. On the north head where the rocks were associated with much dead and a little living coral, five genera with eight species were taken, none being very plentiful. Stone Island, at the entrance to the Port, is most diversified in formation. Granite, felsite, diorite, with volcanic dykes, and, on the north-western point, Permo-Carboniferous rocks prevail; rocky points project seaward, and between them lie shallow beaches of coral sand and debris with scattered stones embedded. Here I took four of the species found on North Head, and four others, three belonging to genera not represented at North Head. The total for Port Denison therefore amounted to eight genera and twelve species.

The furthest north on the Queensland coast where I have collected is Magnetic

Island, off Townsville. This Island is principally granite, interspersed with altered volcanic rocks. My collecting was confined to granite with much coral sand and debris. Five genera and six species were collected.

From Townsville to Albany is a far cry, but the south-western port is in granite country, with an addition that appears of supreme importance to the Loricates—the presence of limestone. It was in 1921 that I spent several days collecting in King George and Queen Charlotte Sounds, where 120 years previously Peron and Lesueur collected the shells, now in the Paris Museum, which are accepted as the types of many well-known Australian species. The remarkable fact that the tides in this locality rarely exceed a rise of two feet not only facilitates littoral collecting, but tends to a concentration of a fauna which would otherwise be scattered over a considerable area. Here I found a fairly large number of species and abundant individuals of many of them. Along the rocks of the upper zone were countless examples of the shell that Blainville named *Chiton hirtosus* in 1825 (I have recently proposed the genus *Clavarizona* with this shell as the type); under stones in the lower zones were several species of *Ischnochiton* and *Acanthochiton*, and representatives of the genera *Rhyssoplax*, *Cryptoplax*, *Lorica*, *Onithochiton*, *Callistochiton*, and *Terenochiton*. Over the Harbour, at the Quarantine Ground, I found a bed of *Zostera*, the plants of which were inhabited by numerous species of *Stenochiton*, those curious elongated Loricates that take up their station on the leaves and inside the root sheaths of the sea-grasses. When Blainville described *Chiton longicymba* in 1825, a confusion of locality evidently occurred, for he gave the type locality as King Island, a place where Peron and Lesueur collected also in 1802. I have since visited that Island, and failed to find either the *Zostera* or the *Stenochiton*. I may here mention a curious coincidence. On my way to King Island, and when boarding the s.s. *Marrawah* which was to convey me there, I noticed an old hulk with a high square stern, lying alongside the steamer. The hulk was named *Geographe*, the name of Baudin's discovery ship on which Peron was the naturalist. To return to King George Sound, it is necessary to state that the *Zostera* bed on which the Stenochitons found such congenial shelter, was situated on a limestone outcrop terminating in a weathered group of rocks amongst which I found quite a number of other Loricates.

From the Sound I proceeded eastwards, calling at Bremer Bay and Hopetoun, where a few hours were spent in collecting. The former locality was unrelieved granite, and only three species of Loricates were taken, one being represented by a single individual. At Hopetoun there is a reef of limestone, and in the pools I found two examples of the rare *Strigichiton verconis* Torr, of which so far only four specimens are known, the other two being from Ellenbrook and Bernier Island on the west coast. Several other species were present in numbers, but the time available was not sufficient to make a complete examination of the reef. From there I went to Esperance Bay, and worked out amongst the islands of the Archipelago of the Recherche. The coast and islands consist of high granite hills, some rounded and others weathered into peaks, devoid of vegetation except in the ravines. Some of these hills exceed 1,000 feet in altitude. The shore line is mostly dazzling white sand, and in most cases where a point of rock juts into the water it is of solid granite, worn smooth by the sea, and slippery from the weed which grows to high water mark. Here I found few Loricates. The hardy *Clavarizona hirtosa* was found in some comparatively sheltered portions of Dempster Head, and the valves of a *Poneroplax* disgorged by a Pacific Gull, were picked up on the Esperance jetty. On Woody Island there is a small bight

with a beach and adjacent boulders. Here four species of Loricates were taken in small quantities. Rounding Cape le Grand, about 25 miles from Esperance, we entered and camped in Lucky Bay, a shallow bay with sandy beach sheltered by two bold granite headlands. Behind the western head, where we camped, there is a very sheltered cove with a few yards of cliff debris on the water's edge, and a reef of white limestone outcropping on the beach and extending almost across to the headland. In this shallow cove there is an extensive bed of *Zostera*. The few movable stones of the cliff debris were well sprinkled with several species of Loricates, and the *Zostera* was simply infested with Stenochitons, *S. longicymba* down in the root sheaths, and *S. posidonialis* Ashby on the leaves. A few spadefuls of the roots dug up and brought ashore in a kerosene tin afforded me several hours of pleasure in searching out and preparing the shells for preservation. On returning to Esperance I went out on a similar bank of *Zostera* under the shelter of Dempster Head. An hour's hard work in digging up and examining the seagrass did not result in a single shell of any description! I therefore conclude that the presence of the shells in the other two instances was due to the association of the limestone with the granite.

In 1922 I visited King Island, Bass Strait, and collected Loricates in Sea Elephant Bay, wading over the reefs examined by Peron 120 years previously. By another curious coincidence W. L. May, of Tasmania, had been moved to do the same thing a few days before me, although we were quite unaware each of the other's movements until later, when we pooled our results. I have already referred to the absence of the *Stenochiton longicymba* which Blainville attributed to "rivages de l'Ile King," and which May, collecting at other points on the Island, had also failed to locate. As shown by Debenham (Journ. Roy. Soc. N.S.W., xliv., 1910, 560) the Island blocks up rather more than a quarter of the western entrance to Bass Strait. On the west coast it is buttressed by large batholiths of granite—grey biotite-granites with accessory muscovite. Currie Harbour is situated about the middle of the west coast, and I collected here and to the south, also at Whistler Point, south of Yellow Rock R., near the north-western point of the Island. Currie Harbour is sheltered, with abundant growth of kelp and other seaweeds, with patches of the sea grass *Cymodocea*. The total results for the west coast were five genera and seven species of Loricates, four species being represented by numerous individuals. One, *Heterozona subviridis*, was present in such profusion that it was not unusual to find fifty specimens clustering on a small stone having less than a square foot of under surface. On the eastern shore I collected at Fraser or Sea Elephant Bay. Debenham is uncertain as to the formation here, stating that the basalt shown on the map south of the Fraser River is on slender evidence only. He appears to consider that closer examination will show that there are dykes of dolerite with porphyritic felspars. So far as I could ascertain Fraser Bluff and the reefs near the jetty are of porphyry, but there is evidence of decomposition, and many rock pools exist, well furnished with loose stones offering shelter to numerous Loricates. Here I collected fifteen species belonging to seven genera, four species being represented by numerous individuals, as on the western coast.

During the past three years I have paid several visits to Shellharbour, sixty miles south of Port Jackson, and have also received very material assistance from Mr. McAndrew, a resident and a keen collector. The artificial harbour has been formed by building a causeway across the narrow strait that formerly existed between Cowrie Island and the mainland; while a concrete breakwater has been built out from the shore to the south of the island, with an arm extending southwards

from the island itself. A very snug little harbour is thus provided, and it has yielded a splendid harvest of Loricates. Cowrie Island and Cemetery Point are of Jamberoo tuffs, and on both sides there is basalt. A mile of beach extends to the south of the harbour, and there the basalt with included masses of volcanic tuffs extends to Point Bass. In the harbour there is a large accumulation of loose boulders on the northern side, mixed with quantities of debris from the harbour works, and ballast discharged from visiting vessels. In this favoured spot we have taken twenty-eight species belonging to eighteen genera, and the possibilities of the place do not appear to be exhausted yet. Here there are no rock-pools in the accepted sense of the term, but merely an expanse of rather muddy sand strewn with more or less movable boulders and stones. There are several beds of *Zostera*, but they harbour no representatives of the genus *Stenochiton*, although some of the common Ischnochitons are found taking shelter in the root sheaths. A marked feature of this spot is the abundance of species of *Rhyssoplax*, all five of the New South Wales species being represented, three of them in comparatively large numbers. The colours of the latter are remarkably diversified and beautiful. The basalt rock pools towards Point Bass are holes weathered in the lava flow, and beneath this flow, just below sea level, lie the marine sandstones. These pools, with their sandstone association, yielded 25 species belonging to sixteen genera. Here again, the field has been by no means exhausted.

In addition to the collections made personally, I have received representative gatherings from Twofold Bay, N.S.W., Mallacoota Inlet, Port Fairy, and Portland, Victoria; north-western and southern Tasmania, and from various localities in South Australia, with some general idea as to the geological formation where the collections were made.

Conclusions.

From the foregoing observations I conclude:—

1. That the Loricates exhibit a marked preference for sandstone, limestone, and other sedimentary rocks, the number of species exceeding twenty-five, and there being a wealth of individuals.

2. That volcanic rocks are marked by a sparse Loricate fauna, both of species and individuals, the number of species never exceeding ten, less than half of which are at all plentiful.

3. Where volcanic rocks are in association with, or immediately overlie sandstone or limestone, the Loricate fauna at once assumes considerable proportions.

4. The foregoing apply, notwithstanding the existence of similar conditions of shelter, food plants, and constant supply of pure sea-water.

I gratefully acknowledge the assistance afforded me in the identification of the rocks of the littoral of Queensland by Mr. B. Dunstan, Chief Government Geologist; and by Messrs. Andrews (Government Geologist), Harper and Dun of the New South Wales Geological Survey, as regards the rocks of this State.

The relation of the flora to the country rock has received considerable attention, and in this respect I would refer with appreciation to a paper by Mr. R. H. Cambage on the Native Flora of Tropical Queensland (Journ. Roy. Soc. N.S.W., xlix., 1915) in which he gives copious information as to the nature of the rock or soil at each locality visited, and draws interesting deductions as to the effect of the soil upon the vegetation or the variations in plants as possibly resulting from adaptation to environment. Dr. Jensen lectured at the December, 1921, meeting of the Queensland Naturalists' Club on "The Relationship between Soil,

Forest Flora, and Geological Formation"; and he also published a series of articles on the same subject in the Queensland Agricultural Journal, 1921-2. Other references could be given, but it is sufficient to show that the relation of the flora to the rock is the subject of attention. One finds less reference to the fauna in relation to the rocks, but Dr. Spencer Roberts and Mr. Hubert Jarvis contributed a paper to the Emu (xxii., April, 1923, 288) on the "Small Birds of the Granite Belt," the meeting point of the Dividing Range of South Queensland and the New England Highland.

There is much in the investigations of the zoologist that depends upon at least a superficial knowledge of the country rock; to the conchologist, perhaps, more than to any other observer. In discussing my predecessor's presidential address, referring particularly to the section dealing with the need for a biological survey, Professor Harrison said "Zoology is waiting until Botany and Geology have completed their investigations," and he appealed to research students to get on with their work in ecology and geological survey, so that the ground may be cleared for a biological survey. May I suggest that the three go hand in hand in parties taking definite sections—the geologist to make a survey of the surface; the botanist to identify the plants and plot their incidence on the geologist's sketch map; and the zoologist to collect or list the fauna and note its ecology. Much more effective work could be done by such a co-operative method.

In the course of collecting Loricates one meets with many observers curious to know the objects of the search. "Bait?" is the usual laconic query, and though some scoff when shown the shells sought for, others remain to admire and learn. My old friend Dr. Torr, of Adelaide, relates with gusto an encounter he had with a scoffer. The doctor, over seventy years of age, but still a keen collector, was up to his waist in a pool picking some desired specimens from stones raised from the bottom. "Whadyer gettin'?" inquired a shore loafer. "Chitons," replied the doctor. "Can yer eat 'em?" was the next inquiry. "No." "Can yer sell 'em?" "No." "Well whads ther good of gettin' 'em?" The doctor, who is a master of homiletics, could not let such an opportunity pass. "My good man," said he, "mankind may be broadly divided into three classes:—those whose god is their belly, those whose god is boodle—and you might represent either class. The third find their worship in the exercise of their brains. *Good* afternoon."

There is a very large section of our community comprising men of political and financial standing and importance, whose attitude towards scientific work is that of Dr. Torr's interlocutor. "What is it worth—in money or goods?" is the question, actual or implied, always on the lips of these men. They are incapable of appreciating or unwilling to admit the value of research or systematic work, the results of which cannot be immediately expressed in terms of cash or barter.

Sometimes a remark by a passing observer as to the collector's labours or personal appearance is humorous, but I will always remember the remark of the little girl, who, after watching the great cairns of stones accumulating in my wake, called out "Say, mister. What are you collecting all them rocks for?"

One word in conclusion before I finally vacate this chair. You are aware that hitherto it has been tacitly understood that when a member of Council was elected President, his term should extend over a second year should he so desire. Some time ago a discussion took place in your Council on the question and it appeared to be the general opinion that this *lex non scripta* should be abrogated. I am desirous of carrying on investigations in other States during the current year and I therefore relinquish this chair in favour of my esteemed colleague in recognition of the Council's opinion and in furtherance of my personal inclinations.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1923, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that they be received and adopted which was carried unanimously.

No nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

President: Mr. R. H. Cambage, F.L.S.

Members of Council (to fill six vacancies): Messrs. W. W. Froggatt, F.L.S., A. G. Hamilton, C. Hedley, F.L.S., T. Steel, G. A. Waterhouse, B.Sc., B.E., F.E.S., and Prof. L. Harrison, B.A., B.Sc.

Auditor: Mr. F. H. Rayment, F.C.P.A.

A cordial vote of thanks to the retiring President was carried by acclamation.

EXPLANATION OF PLATES I.—III.

Plate i.

Upper.—Cowrie Island, Shellharbour, N.S.W. Easter, 1923.
Lower.——Shellharbour. N.S.W. Easter, 1923.

Plate ii.

Upper.—Moffat Head, Caloundra, Q. Northern end of beach.
Lower.—Point Cartwright, Q.

Plate iii.

Upper.—Port Macquarie, N.S.W.
Lower.—Magnetic Island, near Townsville, Q.

Linnean Society of New South Wales

GENERAL ACCOUNT. **Balance Sheet at 31st December, 1923.**

LIABILITIES.

	£ s. d.	£ s. d.
Capital: Amount received from Sir Wm.		
Macleay during his lifetime	14,000 0 0	
Further sum bequeathed by his Will	6,000 0 0	
		20,000 0 0
Contingencies Reserve		1,200 0 0
Income A/c. at 31st December, 1923		396 2 0
Commercial Banking Co., of Sydney, Ltd.		9,601 13 4
		£31,197 15 4

ASSETS.

	£ s. d.	£ s. d.
Society's Freehold		11,000 0 0
Investments: Commonwealth Loans	9,780 0 0	
Loans on Mortgage	10,400 0 0	
		20,180 0 0
Cash: Savings Bank	6 14 4	
In hand	11 1 0	
		17 15 4
		£31,197 15 4

INCOME ACCOUNT. **Year ended 31st December, 1923.**

	£ s. d.	£ s. d.
To Salaries, Wages, and Retired Allowance		1,078 0 0
„ Printing Publications	653 2 6	
„ Illustrations	186 2 2	
		839 4 8
„ Rates	56 15 2	
„ Fire Insurance	19 6 8	
		76 1 10
„ Postage	57 17 3	
„ Telephone	13 8 4	
„ Audit Fee	7 7 0	
„ Bank Expenses	2 8 2	
„ Repairs and Furniture	14 10 6	
„ Expenses	23 6 2	
„ Petty Cash	30 7 5	
		149 4 10
„ Legal Expenses and Stamp Duty	124 5 6	
„ Architect's and Valuer's Fees	13 13 0	
		137 18 6
„ Care (in perpetuity) of Sir Wm. Macleay's Grave		37 10 0
„ Library and Bookbinding		110 13 10
„ Appropriations: Contingencies Reserve	100 0 0	
In reduction of Value of Freehold	105 0 0	
		205 0 0
„ Balance to 1924		396 2 0
		£3,029 15 8

	£ s. d.	£ s. d.
By Balance from 1922		274 12 2
„ Subscriptions, 1923	159 12 0	
„ „ Arrears	13 13 0	
„ „ in Advance	6 6 0	
		179 11 0
„ Entrance Fees		13 13 0
„ Interest on Investments		1,320 3 8
„ Sales (including 100 copies of Proceedings purchased by Government of N.S.W.)		201 14 9
„ Bonus on Loan Conversion		19 13 0
„ Fellowship A/c. (Surplus Income Transferred)		1,020 8 1
		£3,029 15 8

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor.
19th February, 1924.

Sydney, 12th January, 1924.

J. H. CAMPBELL,
Hon. Treasurer.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1923.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0	Commonwealth Loans	7,820	0	0
Surplus Income capitalised	9,400	0	0	Loans on Mortgage	38,080	0	0
Commercial Banking Coy., of Sydney	1,500	0	0				
	£45,900	0	0		£45,900	0	0

INCOME ACCOUNT. Year ended 31st December, 1923.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	1,300	0	0	By Interest on Investments	2,765	10	1
„ Fellows' Subsidies	85	9	0	„ Bonus on Loan Conversion	40	7	0
„ Capital A/c.	400	0	0				
„ General A/c.	1,020	8	1				
	£2,805	17	1		£2,805	17	1

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

19th February, 1924.

Sydney, 12th January, 1924.

J. H. CAMPBELL,
Hon. Treasurer.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1923.

LIABILITIES.

	£	s.	d.
Amount bequeathed by Sir Wm Macleay	12,000	0	0
Accumulated Income capitalised	2,000	0	0
Income A/c, at 31st December, 1923	828	6	1
	£14,828	6	1

ASSETS.

	£	s.	d.	£	s.	d.
Commonwealth Loans				14,400	0	0
Cash Commercial Banking Coy.	318	15	1			
Savings Bank	103	11	0			
In hand	6	0	0			
				428	6	1
				£14,828	6	1

INCOME ACCOUNT. Year ended 31st December, 1923.

	£	s.	d.
To Salary and Wages	574	0	0
„ Expenses	23	11	5
„ Petty Cash	21	6	6
„ Balance to 1924	828	6	1
	£1,447	4	0

	£	s.	d.
By Balance from 1922	579	13	0
„ Interest on Investments	727	11	0
„ Bonus on Loan Conversion	140	0	0
	£1,447	4	0

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor

19th February, 1924.

J. H. CAMPBELL.
Hon Treasurer

Sydney, 12th January, 1924.

ABSTRACT OF PROCEEDINGS

ORDINARY MONTHLY MEETING.

26th March, 1924.

Mr. R. H. Cambage, F.L.S., President, in the Chair.

A letter was read from Mrs. Deane, returning thanks for sympathy in the death of her husband.

The Donations and Exchanges received since the previous Monthly Meeting (28th November, 1923), amounting to 24 Vols., 256 Parts or Nos., 58 Bulletins, 22 Reports and 66 Pamphlets, etc., received from 125 Societies and Institutions and 4 private donors were laid upon the table.

PAPERS READ.

1. Australian Coleoptera. Notes and new species, No. 3. By H. J. Carter, B.A., F.E.S.

2. Studies in the vegetation of arid and semiarid New South Wales. Part ii. The Botanical Features of the Grey Range and its neighbourhood. By Marjorie I. Collins, B.Sc., Linnean Macleay Fellow of the Society in Botany.

3. New trilobites from Bowning, with notes on *Encrinurus* and *Cordania*. By John Mitchell.

4. Studies in parasitism. i. A contribution to the physiology of the genus *Cassytha*. By J. McLuckie, M.A., D.Sc.

Mr. E. Cheel exhibited a specimen of sclerotium or so-called "Black-fellow's bread" collected at Mount Wilson by Mr. J. J. Sloan, on the 10th of March, which had developed six well formed and definite pilei or spore-bearing caps of a creamy-white colour with zones of a lemon-yellow tint tending to egg-yolk colour when matured. From the fissures eight other partially developed pilei were observed, but the contents of the sclerotium having been absorbed, the latter were not developed beyond $\frac{3}{4}$ of an inch.

ORDINARY MONTHLY MEETING.

30th April, 1924.

Mr. R. H. Cambage, President, in the Chair.

Miss Ida Alison Brown, B.Sc., Geology Department, The University of Sydney; Dr. Edwin Claud Chisholm, Comboyne; Mr. Reginald Ernest Dickinson, B.Sc. Eng. (Lond.), A.M.I.C.E., Engineer, N.S.W. Government Railways, and Mr. Francis Basset Hull, "Tolosa," Wemyss Street, Marrickville were elected Ordinary Members of the Society.

The President announced that the Council had elected Professor H. G. Chapman, M.D., B.S., and Messrs. J. J. Fletcher, M.A., B.Sc., G. A. Waterhouse, B.Sc., B.E., F.E.S., and A. F. Basset Hull to be Vice-Presidents and Mr. J. H. Campbell, M.B.E., to be Honorary Treasurer for the current session, 1924-25.

The Donations and Exchanges received since the previous Monthly Meeting (26th March, 1924), amounting to 27 Vols., 160 Parts or Nos., 2 Bulletins, and 1 Report, received from 71 Societies and Institutions and 9 private donors were laid upon the table.

PAPERS READ.

1. The Loranthaceae of Australia. Part v. By W. F. Blakely.

2. A critical revision of the Australian and New Zealand species of the genus *Secotium*. By G. H. Cunningham. (*Communicated by Professor J. B. Cleland*).

3. Studies in the Epacridaceae. i. The life-history of *Styphelia longifolia* (R.Br.). By P. Brough, M.A., B.Sc., B.Sc. Ag.

4. A monograph of the freshwater Entomostraca of New South Wales. Part iv. Phyllopoda. By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited a number of examples of an *Amphioxus* (*Branchiostoma* sp.) which had been sent to him by Professor S. F. Light, Professor of Zoology in the University of Amoy in China. Professor Light had recently described an Amphioxus fishery of a most extensive character—quite unique in the world—which has existed for hundreds of years at the village of Liuwutien, six miles from the University. As much as 2,600 lbs. weight of these organisms is taken each day during the 9 months of the fishery each year.

Mr. W. W. Froggatt exhibited specimens of beetle borers and their parasites taken from red Louan sawn timber imported from the Philippines: (i.) a bostrychid beetle, *Xylothrips flavipes* Zell., which bores and lays its eggs in the dry sapwood; (ii.) a lyctid beetle, *Lyctopholus rugicollis* Walker; (iii.) three coleopterous parasites and one braconid wasp parasitic on these beetles.

Professor L. Harrison exhibited an irregularly conical shaped object about 8 inches in height found in an air space under a step at the entrance to the Macleay Museum. It appeared to be made up of pellets of earth around a central cylindrical opening about 2 inches in diameter, the opening being continued into the ground. Mr. Froggatt suggested that it had been built by a Cicada, similar structures, not quite so large, being of common occurrence in some parts of America.

ORDINARY MONTHLY MEETING.

28th May, 1924.

Mr. R. H. Cambage, President, in the Chair.

The President announced that the Society's offices had been removed to 16 College Street and that the Council had decided on the name "Macleay House" for the Society's house.

The President, on behalf of members, offered congratulations to Dr. G. A. Waterhouse on obtaining his doctorate of science of the University of Sydney, Miss M. I. Collins, on obtaining the degree of Master of Science of the University of Sydney and Mr. I. M. Mackerras, on being awarded the John Coutts Scholarship by the University of Sydney.

The Donations and Exchanges received since the previous Monthly Meeting (30th April, 1924), amounting to 10 Vols., 117 Parts or Nos., 4 Bulletins, 4 Reports and 1 Pamphlet, received from 57 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Eucalypts of the Blue Mountains and their defined areas. By E. C. Chisholm. (*Communicated by Mr. J. H. Maiden*).

2. Notes on Australian Diptera. No. ii. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson*).

3. The food-plants or hosts of some Fijian insects. Part 2. By R. Veitch, B.Sc., and W. Greenwood.

4. Observations on *Helix aspera* in Australia. By T. Steel.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium, (1) a teratological specimen of *Asparagus officinalis* L., (Wagga Wagga, Bishop J. W. Dwyer) showing fasciation of the stem, which measured 31 inches long, and 1¼ in. broad, the greater portion of which showed ribbon-growth, and a small portion of the top winding-growth. (2) *Silene nocturna* L., Night-flowering Catchfly, which appears to be new for the State. It is a native of the Mediterranean, and like *S. gallica*, which it closely resembles, it is now a common weed in cultivation in nearly all parts of the world. It is a more glabrous plant than *S. gallica*, and has longer and more cylindrical capsules. It was first brought under notice by Mr. D. Cross, Dundas, who said that it is very common, and grows in association with *S. gallica*. Mr. T. R. Harrison, Hawkesbury Agricultural College, Richmond, says that it is in restricted areas at the College, and appears to be well established.

Mr. E. Cheel exhibited specimens of *Mimulus moschatus*, cultivated in the Botanic Gardens, which showed the same characteristics as the old-fashioned sweet-scented Musk Plant, but like most of the present-day plants cultivated in Great Britain, it had lost its musk-like odour. It is interesting to note that specimens have been collected on the Upper Murray, Victoria, by Mr. A. Quinn in December, 1905; also at Queanbeyan, N.S.W., by Mr. R. H. Cambage in December, 1912, which latter the late Mr. E. Betche noted "seemed to be an escape from cultivation" and "apparently naturalised" respectively. No mention is made by the collectors as to the loss of scent in the naturalised plants, but Mr. Cheel states that some plants having the distinctive musk-like odour were cultivated by Mr. J. McRae, Propagator in the Centennial Park, during the years 1898-1900.

In view of the discussion that has taken place in the daily press as well as in Scientific and Horticultural Publications, concerning the loss of scent in present-day plants, it would be of special interest to locate a plant having the musk-like odour, as they appear to be unobtainable in Great Britain. Mr. Cheel also exhibited specimens of the "Californian Straw Flower" (*Collomia grandiflora* Dang.) collected by Dr. F. A. Rodway on the Upper Tumut River near Kiandra, and at Wolseley Park, Wagga Wagga, by Mr. P. G. Ricel, which shows that the plant is spreading since it was first recorded from Canoblas, Orange (see Agric. Gaz. N.S.W., xv., 1904, 624).

Mr. T. Steel remarked that the specimen exhibited by Professor Harrison at the April meeting, appeared, from the description in the Abstract, to agree with the tubular entrance of the burrow of *Engaeus,* a burrowing land crayfish.

With reference to Mr. Steel's remarks, Mr. D. G. Stead stated that the position of the formation referred to (at the top of a hill in hard shales, far removed from water) and its structure precluded the possibility of there being any connection with burrows of *Engaeus* or other burrowing crayfish.

Professor A. A. Lawson exhibited some lantern slides of orchids.

ORDINARY MONTHLY MEETING.

25th JUNE, 1924.

Mr. R. H. Cambage, President, in the Chair.

The President offered congratulations to Dr. Darnell Smith on his appointment as Director of the Botanic Gardens.

The Donations and Exchanges received since the previous Monthly Meeting (28th May, 1924), amounting to 1 Vol., 78 Parts or Nos., 12 Bulletins, 2 Reports and 1 Pamphlet, received from 46 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. Two new thrips-galls and their inhabitants from New South Wales. By W. Docters van Leeuwen and H. H. Karny. (*Communicated by Mr. J. H. Maiden*).

2. On some Australian Scarabaeidae. By A. M. Lea.

3. Results of Roy Bell's Molluscan Collections. By T. Iredale. (*Communicated by Mr. C. Hedley*).

NOTES AND EXHIBITS.

Mr. E. Le G. Troughton exhibited (by permission of the Director of the Australian Museum) a photograph and specimen of a female insectivorous bat, *Nyctinomus australis* Gray, 1838, from Mittagong, N.S.W. The specimen is in the Museum collection, together with another from the Taree District, N.S.W. Both are females and have pure white stripes of fur on the under-surface of the lateral membranes, and well developed gular sacs, which characters are described as typical of the female of the South Australian species, *N. albidus* Leche, 1884. In 1906, Thomas recorded *australis* from south-western Australia, and stated that his specimen did not differ in any important respect from Gray's type; Collett (1887) described a female having an indistinct gular sac, which is said to be typical of the female *australis,* and white under-wing fur characteristic of the female *albidus*. In consideration of the plastic nature of the characters used to separate the two species, the wide range now covered by *australis,* and the variation displayed by female specimens, the exhibitor feels justified in assuming *albidus* to be synonymous with *australis,* of which species it is merely a variation due to age or seasonal changes.

Mr. E. Le G. Troughton exhibited a specimen of the White-backed Wren (*Malurus leuconotus* Gould) which he had collected at Mt. Lyndhurst, 30 miles east of Farina, South Australia. Mr. Iredale pointed out that this species had been described by Gould nearly sixty years ago, and the type being lost, had been recently removed from the list of Australian Birds, the supposition being

that the species had been based upon a freak skin. Mr. Troughton's specimen proved that *M. leuconotus* was a valid species, apparently restricted in range, and probably Gould's specimen had been collected in the same locality whence the bird now exhibited was procured. As Gould's type was lost, the present bird could be regarded as a neotype, and was probably one of the most interesting birds exhibited before this Society.

Dr. G. A. Waterhouse exhibited a second generation hybrid (female) from his series of crosses. The original cross was *Tisiphone abeona* x *T. morrisi*. This specimen shows the forewings closely approximating in colour to the forewings of *abeona* whilst the hindwings are almost identical in colour and markings with the hindwings of *morrisi*.

This being the last meeting in the Linnean Hall at Elizabeth Bay, the President referred to the circumstances under which the Society became possessed of the Hall through the generosity of Sir William Macleay, as well as to the many other ways in which the Society was indebted to Sir William. Other members (Messrs. J. J. Fletcher, R. T. Baker, W. W. Froggatt, A. G. Hamilton, D. G. Stead and Dr. A. B. Walkom) recounted what the Society owed Sir William, without whose munificence the Society could not have succeeded as it has done. It is hoped that a short historical account of the Society will be published for members in connection with the Jubilee celebrations early next year.

As this was the last meeting to be held in the Linnean Hall at Elizabeth Bay, a flashlight photograph was taken of the meeting in order that there might be a permanent record.

ORDINARY MONTHLY MEETING.

26th July, 1924.

(At Macleay House, 16 College Street, Sydney).

Mr. R. H. Cambage, President, in the Chair.

The President drew attention to the fact that this meeting, the first held in the Society's new home, marked a distinct step in the development of the Society and would, in time to come, be looked back upon by members as one of great historic interest.

Dr. C. Anderson, president of the Royal Society of New South Wales, conveyed a friendly message from the Council of that Society extending cordial greetings and expressing the hope that the friendly co-operation between the two societies, for the advancement of science, might ever continue.

On the motion of Mr. A. F. Basset Hull, it was resolved that the message be acknowledged, and the hope reiterated that the friendly spirit of co-operation between the two societies might always exist.

Mr. James Roy Kinghorn, Australian Museum, Sydney, was elected an Ordinary Member of the Society.

A letter was read from Dr. G. P. Darnell Smith, returning thanks for congratulations.

The President offered congratulations to Dr. A. N. Burkitt on his appointment as Associate Professor of Anatomy in the University of Sydney.

The President announced that Mr. C. Hedley, who had been a Member of Council since 1897, had resigned from the Council on account of his continued absence in Queensland, and that Professor A. A. Lawson had also resigned from

the Council; also that the Council had elected Mr. A. R. McCulloch, of the Australian Museum, to fill the vacancy caused by Mr. Hedley's resignation.

The Donations and Exchanges received since the previous Monthly Meeting (25th June, 1924), amounting to 14 Vols., 127 Parts or Nos., 13 Bulletins, 5 Reports and 4 Pamphlets., etc., received from 63 Societies and Institutions and 4 private donors were laid upon the table.

PAPERS READ.

1. Notes on breeding Entomostraca from dried mud, and their habits in aquaria. By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

2. Entomostraca collected in the vicinity of Auckland, N.Z. By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

3. Notes on Australian Diptera. No. iii. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson*).

4. A revision of the Australian Chiromyzini (Diptera). By G. H. Hardy.

NOTES AND EXHIBITS.

Dr. G. A. Waterhouse exhibited larvae of *Philiris ilias innotatus* Misk. He pointed out that these larvae were very different in shape from those of *Candalides*, of which genus *Philiris* is considered a synonym. On a previous occasion he had exhibited pupae of *Philiris*, which also differ very much from pupae of *Candalides*. Though the venation of both *Candalides* and *Philiris* is very similar, the butterflies of these two genera have a very different facies and this, combined with the great differences in both larvae and pupae, has confirmed his previous opinion that the two should be kept as distinct genera.

He also exhibited a specimen of *Loranthus linophyllus* found growing on *Casuarina glauca* between Mona Vale and Bay View, a few miles distant from Newport where it had been recorded by Mr. R. H. Cambage. This parasite is of infrequent occurrence in the County of Cumberland, but was growing on many she-oaks near Mona Vale.

Mr. E. Cheel exhibited a fine series of specimens of the common Port Jackson Fig (*Ficus rubiginosa* Vent.) collected from trees in The Botanic Gardens, Government Domains and various Parks and private gardens in the Sydney district, showing extreme variation in the size and shape of the leaves and fruits, as well as in the colour of the indumentum. Other examples collected by Dr. J. B. Cleland and himself from 32 trees growing naturally from Mosman to Cremorne Point, and from Narrabeen by Dr. Cleland, were also shown for comparison with the cultivated plants. It was suggested that some of the forms may be identical with *F. platypoda* and the doubtful varieties *mollis*, *petiolaris* and *minor* of Bentham.

Mr. A. M. Lea exhibited specimens of the coconut moth (*Levuana iridescens*) in its various stages; this insect is now very destructive to the copra industry in some Fijian islands and efforts are being made to secure parasites to keep it in check.

Mr. A. Musgrave exhibited some lantern slides of views of Lord Howe Island.

ORDINARY MONTHLY MEETING.

27th August, 1924.

(At Macleay House, 16 College Street, Sydney.)

Mr. J. J. Fletcher, M.A., B.Sc., Vice-President, in the Chair.

The Chairman announced that Dr. W. R. Browne had been elected a member of Council to fill the vacancy caused by the resignation of Professor Lawson.

The Chairman offered congratulations to Miss Marjorie I. Collins, who had been awarded a Dominion Research Scholarship for the year 1924-25, tenable at the Imperial College of Science and Technology, London.

Mr. Frederick Hugh Sherston Roberts, B.Sc., Prickly Pear Laboratory, Sherwood, Brisbane, Queensland, was elected an ordinary member of the Society.

The Donations and Exchanges received since the previous Monthly Meeting (30th July, 1924), amounting to 11 Vols., 83 Parts or Nos., 8 Bulletins, 1 Report and 1 Pamphlet, received from 53 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. The Nectar of Flowers. By T. Steel.
2. An Australian Caryophyllaeid Cestode. By Professor T. Harvey Johnston, M.A., D.Sc.
3. Notes on Australian Diptera. No. iv. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson.*)
4. The motor nerve-endings of the limb muscles of the frog (*Rana temporaria*) and of the muscles of the pectoral fin of the Dog-fish (*Squalus acanthias*). By P. D. F. Murray, B.Sc., Linnean Macleay Fellow of the Society in Zoology.
5. Studies in Plant Pigments. Part ii. The red pigment induced by insect injury in *Eucalyptus stricta*. By J. M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Bio-chemistry.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited the life history of the green wood moth, *Charagia eximia* Scott; the stem of the tree with covering and bore containing the larva; also the cap and section of a bore into another tree trunk, a larva, and two of the female moths from Brooklana, Dorrigo, N.S.W.

Mr. A. S. Le Souef exhibited skins of two new rock wallabies; one, allied to the yellow-footed rock wallaby, from Bulloo River, S.W. Queensland, and one from Dajarra, N.W. Queensland.

ORDINARY MONTHLY MEETING.

24th September, 1924.

(At Macleay House, 16 College Street, Sydney).

Mr. R. H. Cambage, F.L.S., President, in the Chair.

The President announced the death of Professor G. B. De Toni, of Modena, Italy, who had been an Honorary Member since 1897 and also of Mr. H. G. Smith, who had been a member since 1899.

The President announced that the Annual Natural History and Wild Flower Exhibition of the Naturalists' Society of New South Wales will be held in the Art Gallery of the Education Department from 9th to 15th October.

The President also announced that the Council is prepared to receive applications for four Linnean Macleay Fellowships tenable for one year from 1st March, 1925, from qualified candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending candidates, not later than Wednesday, 5th November, 1924.

The Donations and Exchanges received since the previous Monthly Meeting (27th August, 1924), amounting to 17 Vols., 131 Parts or Nos., 14 Bulletins, 3 Reports and 1 Pamphlet, received from 56 Societies and Institutions and 1 private donor were laid upon the table.

PAPERS READ.

1. Revision of Australian Lepidoptera. Lasiocampidae.' By A. J. Turner, M.D., F.E.S.

2. Upper Permian Coleoptera and a new Order from the Belmont Beds, N.S.W. By R. J. Tillyard, M.A., D.Sc., F.E.S., F.L.S.

3. A preliminary reference to a new species of *Elonichthys* from the lower beds of the Newcastle Coal Measures. By John Mitchell.

4. Further reference to the occurrence of *Merista plebeia* Sowerby in New South Wales. By John Mitchell.

5. Eleven new species of *Aviculopecten* from Carboniferous rocks, Myall Lakes, N.S.W. By John Mitchell.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited (1) the life-history of the Pin-hole Borer, *Crossotarsus armipennis*, of the Spotted Gum (*Eucalyptus maculata*) from Morisset, N.S.W. This Scolytid beetle bores through the bark of freshly fallen spotted gums and forms radii along galleries in the sap-wood, in which the larvae are developed and pupate. The adult beetles do all the boring, the larvae feeding upon the fungus forming on the walls of the galleries with the fermenting sap; (2) photograph of a Wasp Tree and specimens of wasps and nest. This photograph showed a Blue Gum (*Eucalyptus tereticornis*) growing on the roadside at Brooklana (Dorrigo), on which the Paper Nest Wasps (*Polistes tasmaniensis*) have built many thousands of nests, extending up the sunny side of the trunk for about 30 feet. On his first visit, November, 1923, all these nests were small and separated from each other, now they are all joined together, forming an almost unbroken coating of the tree trunk. Under normal conditions these nests are seldom over a few inches in diameter and the adult wasps feed the larvae with chewed up spiders. How these millions of larvae are fed it is difficult to imagine.

Mr. J. Mitchell exhibited a specimen of a fossil insect wing from Belmont, N.S.W.

Mr. E. Cheel exhibited fresh flowering specimens of *Microcitrus australis* (Planchon) Swingle (Journ. Washington Acad. Sci., v. (16), 1915, 575) (*Citrus australis* Planchon, B. Fl., i., 371), from two plants cultivated in the Botanic Gardens, Sydney. The flowers are mostly 3-merous or occasionally 4-merous, with 18 or 20 free stamens with pollen of a rich orange-yellow colour. Although the plants have flowered in the Gardens three successive seasons, no fruits have set. Specimens in the National Herbarium from Murwillumbah, Ballina, Boat Harbour, Richmond River and Burringbar are identical with the cultivated plants mentioned above and all show that the flowering period is during August to November. There is also a fruiting specimen from a plant cultivated in the

Centennial Park, the fruits being quite globose (about 1 inch diameter). All the above have been mis-determined as *M. australasica* (F.v.M.) Swingle, but the latter has smaller leaves, and cylindric-fusiform fruits. A fresh specimen from a plant cultivated at Ashfield raised from seeds of the true "Finger Lime" was shown for comparison.

ORDINARY MONTHLY MEETING.

29th October, 1924.

(At Macleay House, 16 College Street, Sydney).

Mr. R. H. Cambage, F.L.S., President, in the Chair.

The President called attention to the fact that this meeting took place on the fiftieth anniversary of the first preliminary meeting in connection with the formation of the Society, and announced that at the Annual General Meeting the Jubilee of the Society would be celebrated.

Mr. Fred Wright, Seville Street, Lane Cove, was elected an Ordinary Member of the Society.

A letter was read from Mrs. H. G. Smith and family, returning thanks for expressions of sympathy in their recent bereavement.

Candidates for Linnean Macleay Fellowships, 1925-26, were reminded that Wednesday, 5th November, is the last day for receiving applications.

The Donations and Exchanges received since the previous Monthly Meeting (24th September, 1924), amounting to 8 Vols., 89 Parts or Nos., and 6 Bulletins, received from 45 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. The Influence of certain Colloids upon Fermentation. Part i. By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.
2. Note upon determining the hydrogen-ion concentration colorimetrically in small quantities of fluids. By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.
3. Australian Coleoptera. Notes and new species. No. iv. By H. J. Carter, B.A., F.E.S.
4. Australian Nemestrinidae (Diptera). By G. H. Hardy.

NOTES AND EXHIBITS.

Mr. D. G. Stead gave a short account of the Pan-Pacific Food Conference held recently at Honolulu.

Mr. E. Cheel exhibited specimens of the "Adder's-tongue Fern" (*Ophioglossum Prantlii*) which were found quite common in pasture-land in the neighbourhood of Orange. Although this species has a wide range (vide Handb. Fl. N.S.W.) it is only found on certain soil-formations. Specimens in the National Herbarium, Sydney, are from Riverstone, Lilyvale, Dubbo, Condobolin, Lachlan District, Yandama and Warialda in this State, and from King Island, Tasmania, Lord Howe Island, Norfolk Island, Port Phillip (Victoria), Mount Lofty, S.A., and Central Australia. It has been recorded in various works under the names *O. vulgatum* L., and *O. lanceolatum* Prantl. Christensen (Ind. Fil., 1906, 471) regards this as a distinct species. Oliver (Trans. N.Z. Inst., xlix., 1916, 126) reduces it as a variety under *O. vulgatum*—i.e., *O. vulgatum* var. *Prantlii* (C.Chr.)

Oliver. It seems also very closely allied and may not be specifically distinct from *O. lusitanicum* Willd.

Dr. A. B. Walkom exhibited a specimen collected by Mr. T. H. Pincombe showing scale-leaves of *Glossopteris,* with which are associated sporangia similar to those described by Arber but aggregated in groups.

ORDINARY MONTHLY MEETING.

26th NOVEMBER, 1924.

(At Macleay House, 16 College Street, Sydney).

Mr. R. H. Cambage, F.L.S., President, in the Chair.

The President announced that Mr. A. F. Basset Hull had resigned from the Council of the Society, on account of his projected absence from the State during the greater part of the coming year.

The President also announced that the Council had re-appointed Mr. P. D. F. Murray and Miss M. M. Williams to Linnean Macleay Fellowships in Zoology and Botany respectively for another year from 1st March, 1925, and had appointed Dr. I. M. Mackerras and Mr. G. D. Osborne to Fellowships in Zoology and Geology respectively for one year from 1st March, 1925.

The Donations and Exchanges received since the previous Monthly Meeting (29th October, 1924), amounting to 6 Vols., 61 Parts or Nos., 6 Bulletins, 2 Reports and 1 Pamphlet, received from 43 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. Two new Hemiptera from New South Wales. By H. M. Hale. (*Communicated by A. J. Nicholson, M.Sc.*).

2. Critical notes on the Temnocephaloidea. By Professor W. A. Haswell, M.A., D.Sc., F.R.S.

3. An ecological study of the flora of Mt. Wilson. Part i. The vegetation of the basalt. By P. Brough, M.A., B.Sc., J. McLuckie, M.A., D.Sc., and A. H. K. Petrie.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium four introduced plants not hitherto recorded for the State. (1) *Rapistrum hispanicus* (L.) Crantz, var. *hirsutum* (Cariot) O. E. Schulz, Broken Hill (A. Morris, No. 601). (2) *R. rugosum* (L.) All., var. *nervosum* (Pers.) D.C., Junee district (J. B. Nugent). The variety is distinguished from the typical form in being more glabrous. (3) *Myosotis versicolor* (Pers.) Sm., Gilmore, near Tumut (J. L. Boorman). It is said to be distributed throughout Europe, Asia and Africa. In general appearance it is not unlike some small forms of the native species, *M. australis,* from which it can be separated by the longer calyx-segments. (4) *Echium italicum* L., near Young (W. J. Smith). It is an undesirable weed.

Mr. E. Cheel exhibited specimen of *Myriangium montagnei* Berk., collected in the Centennial Park 14th May, 1901, on branches of *Casuarina distyla.* In a paper entitled "Studies in Entomogenous Fungi," by T. Petch (The British Mycological Society Transactions, x., 1924, 75) *Myriangium duriaei,* of Australian authors, together with *M. dolichospermum* Wilson (Proc. Roy. Soc. Vic-

toria, v., 1892, 160) and *M. acaciae* McAlpine (These Proceedings, xxix., 1904, 124) are included as synonyms. Although previously classed under the family Collemaceae of the Lichenes group of plants by several authorities, the genus is now generally regarded as belonging to fungi and included under the family Myriangiaceae. There is a large series of specimens in the National Herbarium, Sydney, usually associated with scale insects on *Hymenanthera dentata* and various species of *Acacia*, in Victoria and other localities in this State.

Mr. David G. Stead related some of his experiences at Honolulu at the Pan-Pacific Food Conservation Conference and described his air flights over the Hawaiian Islands. The remarks were illustrated by lantern slides.

DONATIONS AND EXCHANGES.

Received during the period 29th November, 1923, to 26th November, 1924.

(*From the respective Societies, etc., unless otherwise mentioned.*)

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Welch, M. B., B.Sc., A.I.C., Sydney.—Two Reprints from Journ. & Proc. Roy. Soc. N.S.W., lvii. (1923):—"The Secretory Epidermal Cells of certain Eucalypts and Angophoras"; "Notes on Wattle Barks, Part i.," by M. B. Welch, W. McGlynn and F. A. Coombs.

LIST OF MEMBERS, 1924.

ORDINARY MEMBERS.

1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College St., Sydney.
1922 Anderson, Robert Henry, B.Sc.Agr., Botanic Gardens, Sydney.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1912 Aurousseau, Marcel, B.Sc., c/o Mr. G. H. Aurousseau, "Wondah," Bannerman Street, Cremorne.

1913 Badham, Charles, B.Sc., M.B., Bureau of Microbiology, 93 Macquarie Street, Sydney.
1888 Baker, Richard Thomas, The Avenue, Cheltenham.
1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co., Ltd., O'Connell Street, Sydney.
1907 Benson, Professor William Noel, B.A., D.Sc., F.G.S., University of Otago, Dunedin, N.Z.
1920 Blakely, William Faris, Botanic Gardens, Sydney.
1923 Bone, Walter Henry, 15 Bond Street, Sydney.
1912 Breakwell, Ernest, B.A., B.Sc., Agricultural High School, Yanco, N.S.W.
1912 Brewster, Miss Agnes, Girls' High School, Sydney.
1900 Broelemann, Henry W., Boite 22, a Pau (Basses-Pyrenees), France.
1923 Brough, Patrick, M.A., B.Sc., B.Ag.Sc., "Kinross," Billyard Avenue, Wahroonga.
1921 Brown, Horace William, Post Office, Mackay, Queensland.
1924 Brown, Miss Ida A., B.Sc., Geology Department, The University, Sydney.
1911 Browne, William Rowan, D.Sc., Geology Dept., University of Sydney.
1920 Burkitt, Arthur Neville St. George Handcock, M.B., B.Sc., Medical School University of Sydney.
1921 Burns, Alexander Noble, Westwood, Queensland.
1910 Burrell, Harry, 19 Doncaster Avenue, Kensington.
1910 Burrell, Mrs. Harry, 19 Doncaster Avenue, Kensington.
1924 Butler, Miss Hilda Catherine, "Wenby," North Street, Marrickville.

1912 Cadell, Miss Myall, "Wotonga," Belgium Avenue, Roseville.
1899 Cambage, Richard Hind, L.S., F.L.S., Park Road, Burwood.
1901 Campbell, John Honeyford, M.B.E., Royal Mint, Sydney.
1905 Carne, Walter Mervyn, Government Botanist, Perth, W.A.
1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge St., Sydney.
1903 Carter, H. J., B.A., F.E.S., "Garrawillah," Kintore St., Wahroonga.
1904 Chapman, Professor Henry G., M.D., B.S., Medical School, University of Sydney.
1921 Chase, Miss Eleanor Emily, B.Sc., Zoology Department, The University, Sydney.
1899 Cheel, Edwin, Botanic Gardens, Sydney.
1924 Chisholm, Edwin Claud, M.B., Ch.M., Comboyne, N.S.W.
1920 Clarke, Harry Flockton, c/o Colonial Sugar Refining Co., Ltd., Rarawai Mill, Ba River, Fiji.
1901 Cleland, Professor John Burton, M.D., Ch.M., The University, Adelaide, S.A.
1916 Collins, Miss Marjorie Isabel, M.Sc., Botany Department, The University, Sydney.
1908 Cotton, Professor Leo Arthur, M.A., D.Sc., Geology Dept., University of Sydney.
1900 Crago, William Henry, M.D., 185 Macquarie Street, Sydney.

1920 Danes, Dr. Jiri Victor, Charles University, Prague, Czechoslovakia, Europe.
1885 David, Sir Tannatt William Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., University of Sydney.
1924 Dickinson, Reginald Ernest, B.Sc., Eng. (Lond.), A.M.I.C.E., 6 Hawea Flats, Spofforth Street, Cremorne.
1887 Dixson, Sir Hugh, Kt., J.P., "Abergeldie," Summer Hill.
1881 Dixson, Thomas Storie, M.B., Ch.M., 215 Macquarie Street, Sydney.
1921 Dodd, Alan Parkhurst, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
1923 Drummond, Miss Heather R., "Havilah," Glenbrook, N.S.W.
1920 Dwyer, Rt. Rev. Joseph Wilfrid, Bishop of Wagga, Wagga Wagga, N.S.W.

1920 Elston, Albert H., F.E.S., "Hatherley," Unley Park, S.A.
1914 Enright, Walter John, B.A., West Maitland, N.S.W.

1908 Ferguson, Eustace William, M.B., Ch.M., Bureau of Microbiology, Macquarie Street, Sydney.
1908 Finckh, Herman E., "Hermes," 100 Raglan Street, Mosman.
1881 Fletcher, Joseph J., M.A., B.Sc., Woolwich Road, Woolwich.
1908 Flynn, Professor Theodore Thomson, D.Sc., University of Tasmania, Hobart, Tas.
1920 Friend, Norman Bartlett, 48 Pile Street, Dulwich Hill.
1911 Froggatt, John Lewis, B.Sc., Dept. of Agriculture, Brisbane.
1886 Froggatt, Walter Wilson, F.L.S., Young Street, Croydon.
1920 Furst, Herbert Charles, 6 Old Canterbury Road, Lewisham.

1912 Goldfinch, Gilbert M., "Lyndhurst," Salisbury Road, Rose Bay.
1899 Grant, Robert, 24 Edward Street, Woollahra.
1923 Gray, Archibald James, "Warwick," Fernhill Street, Hurlstone Park.
1911 Greenwood, William Frederick Neville, c/- Colonial Sugar Refining Co., Ltd., Lautoka, Fiji.
1910 Griffiths, Edward, B.Sc., Dept. of Agriculture, 136 Lower George St., Sydney.
1901 Gurney, William B., F.E.S., Dept. of Agriculture, George St. North, Sydney.

1911 Hacker, Henry, Queensland Museum, Bowen Park, Brisbane, Q.
1923 Hajny, Emanuel J., Consul-General for Czechoslovakia, Australia House Carrington Street, Sydney.
1909 Hall, E. Cuthbert, M.D., Ch.M., George Street, Parramatta.
1919 Hall, Leslie Lionel, "Uabba Mansions," Milson Road, Cremorne.
1897 Halligan, Gerald H., F.G.S., 97 Elphin Road, Launceston, Tasmania.
1899 Hamilton, Arthur Andrew, "The Ferns," 17 Thomas Street, Ashfield.
1885 Hamilton, Alexander Greenlaw, "Tanandra," Hercules Street, Chatswood.
1922 Hardwick, Frederick George, B.D.S., D.D.Sc., Molesworth Street, Lismore, N.S.W.
1917 Hardy, G. H. Hurlstone, The University, Brisbane, Q.
1924 Harris, Miss Thistle Y., "Lynette," 71 Spencer Road, Mosman.
1905 Harrison, Professor Launcelot, B.Sc., B.A., Zoology Dept., University of Sydney.
1879 Haswell, Professor William Aitcheson, M.A., D.Sc., F.R.S., "Mimihau," Woollahra Point.
1911 Haviland, The Venerable Archdeacon F. E., St. Thomas' Rectory, O'Connell, N.S.W.
1891 Hedley, Charles, F.L.S., 67 Muston Street, Mosman.
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STUDIES IN THE VEGETATION OF ARID AND SEMI-ARID NEW SOUTH WALES.

Part ii. The Botanical Features of the Grey Range and its Neighbourhood.

By Marjorie I. Collins, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Botany.

(Plates iv.-ix.)

[Read 26th March, 1924.]

Introduction.

As an introduction to a previous paper upon the Plant Ecology of the Barrier District (Collins, 1923) the writer described the physiographic and climatic features of Western New South Wales. It was shown that the extensive sandy plains stretching out to the west of the Main Divide are interrupted at rare intervals by regions of high land, old peneplain surfaces which stand partly buried in their own detritus. The most important of these old residuals are the Cobar peneplain, about 140 miles east of the River Darling, and the Barrier and Grey Ranges in the far west and north-west respectively.

Western New South Wales was further shown to be a region of decreasing annual rainfall as one proceeds from east to west, the region of lowest rainfall in the State, Yandama, being close to the boundaries between New South Wales, Queensland and South Australia.

The choking up of main and subsidiary stream channels with sand and detritus, and the cutting down of new channels in the old creek beds, in addition to other interesting physiographic features, point to the far west of New South Wales being a region of increasing aridity in recent geological time. This being the case, the vegetation of such an area should offer much that is of special interest to the plant ecologist.

In the paper referred to above (Collins, 1923, pp. 246-261) the writer dealt with the plant associations of the various habitats in the Barrier Range, and, as far as she was able, from the data available, discussed the possible developmental relationships of the chief associations.

It was with the intention of adding to the data collected in the Barrier Range, and thereby forming a truer and more complete conception of the relationships of the plant associations, that the Grey Range was visited in 1922.

Although comparatively few species were found in addition to those already listed for the Barrier Range, yet the reaction upon the vegetation of certain physiographic features not previously met, such as the extensive areas of parallel sand ridges and the formation of "gibber" plains and slopes, seems to merit the special consideration of a separate paper. Also, the occurrence of summer rains

will be shown to have some effect upon the nature of the ground flora, an effect not appreciably noticed in the Barrier Range, and one of special interest in a pastoral country.

In connection with this investigation in the Grey Range, the writer is indebted to Dr. W. MacGillivray of Broken Hill for much assistance, to Mr. Fuller of Mt. Poole and Mr. and Mrs. Winton of Yandama Stations for their hospitality and kindness in facilitating the work. The writer also wishes to express her thanks to Mr. J. H. Maiden, F.R.S., and his staff, who placed the facilities of the National Herbarium at her disposal and assisted in the identification of many species.

The Geology and Physiography of the Grey Range.

The Grey Range is a line of low undulating hills extending from about Lat. 30° S., Long. 140° 50', across the New South Wales boundary into Queensland. Although the height of these hills ranges from about 400 to 500 feet above the level of the surrounding plains, there are occasional higher peaks which stand out sharply, such as Mount Poole, Mount Sturt, Mount Browne and Mount Shannon.

The Grey Range is held by certain geologists to be a northerly extension of the Barrier Range, and in age its rocks have been tentatively placed with the Willyama Series (Archaean) of this latter Range. Andrews says in this connection (1922, p. 63) "The North and South axis along which members of the Willyama Series are arranged, is continued to the Queensland border, a distance of 250 miles North from Broken Hill, the older rocks cropping up as small shields and long ridges at distant intervals (Packsaddle, Koonanberry, Mount Arrowsmith, etc.) Of these the most marked are the Tibbooburra and Milparinka groups, distant respectively 210 and 185 miles from Broken Hill."

The most noteworthy of the rocks making up the Grey Range are claystones and slates with a dip ranging from about 60° to vertical, and with a strike of about N. 35° W. (Andrews, 1922, p. 62).

Occasional thin beds of sandstone were observed by the writer interbedded with the slates near Mt. Poole. Large quartz reefs are a consistent feature of the range and are mostly thinly veneered with oxide of iron. The presence of these quartz reefs, and particularly the sheets of quartz rubble resulting from their fragmental weathering, recalls a similar occurrence in the beds of the Torrowangee Series north of Broken Hill. In the case of the Grey Range, however, the silicification appears to have been more intense, hills and plains at the present day being often entirely covered with dazzling white quartz fragments, which, in the distance, give the appearance of snow. Gold, which was at one time mined in the Grey Range and is at the present time often found in the sandy creek beds after rains, was no doubt liberated by the breaking down of these quartz reefs.

Further evidences of silicification are found in the chalcedonised pebbles, agates and jaspers, so common a feature of the rubble and gibber sheets.

Intrusive rocks of the range are chiefly the granite masses, such as that occurring near Tibbooburra, and the diorite dykes which frequently traverse the slates.

An interesting occurrence of sedimentary rocks in the district is that of the Cretaceous sandstones which extend into New South Wales from Queensland as outliers from the Artesian Series. These sandstones are more commonly found *in situ* near Tibbooburra and upon denudation contribute in large measure to the formation of the gibber sheets which are a noteworthy feature of the lower slopes of the Range.

Physiography.

The physiographic features of the Grey Range are still more markedly of an arid cycle than those of the Barrier Range. Streams again originate centrifugally in the hills. The Milparinka and Evelyn Creeks are of note on the eastern flanks and eventually lose themselves on the plains towards the Darling River; while Yandama Creek on the west, flows towards the Lake Callabonna drainage basin.

As in the Barrier Range, these creeks are sandy or pebble-strewn courses lined by gum-trees (*Eucalyptus*). Occasionally waterholes occur in the creek beds, and these are often the sole source of water supply in times of prolonged drought. With a good downpour of rain, however, water runs in these creeks for some hours and floods the surrounding country.

As in the case of the Barrier Range, the Grey Range is surrounded by extensive plains. These are, for the most part, of a red sandy soil, with occasional patches of clay and darker loam in the areas subjected to flooding. The Plains stretch on the south to the Barrier Range and are interrupted at intervals by isolated peaks and ridges, such as Mt. Arrowsmith, Koonanberry Range, Mt. Packsaddle. It is on these plains between the Barrier and Grey Ranges that the extensive clay-pan lakes, Bancannia and Cobham, occur.

In the east the sandy plains stretch to the Darling River, while to the north and west they extend, as an almost endless waste of sand, to the Central Australian Desert.

A feature of these sandy plains, and one not developed to any marked extent near the Barrier Range, is the occurrence of mile after mile of parallel sand ridges separated by clay flats. Mr. H. Y. L. Brown narrates (1883, p. 3) "These plains are chiefly composed of red loam and sand with soft silt depressions, claypans or hard depressed floors, and dry lakes. Further North these depressions become deeper, and the sand ridges commence from here to Yandama Creek; they are composed of loose red sand and vary in height from 30-50 feet, and are placed in roughly parallel rows at distances of from a few inches to a quarter of a mile apart, being separated by long reaches of clay and silt flats."

The trend of these sand ridges appears to vary. The Cobham sand ridges, on the mail route from Broken Hill to Milparinka, cross the track diagonally, trending almost north-east, while west of the Grey Range they are approximately north and south in direction.

In addition to the clay flats between the sand ridges, clay pans of varying size and generally of circular outline occur on the sandy plains and form an important feature of the country after rains.

In the neighbourhood of the range itself and extending out onto the plains for some distance are the gibber or stone sheets.

The gibber plains are perhaps amongst the most characteristic of the physiographic features of desert-arid Australia. Spencer and Gillen say of them (1912, p. 40) "Nothing could possibly be more desolate than these 'gibber fields' . . . . The horizon is shimmering and indistinct, and the level ground is covered with a layer of close-set, purple brown stones, all made smooth and shiny by the constant action of wind-borne sand-grains, for in winter especially, a strong South East wind often blows all day long." The stones making up these gibber sheets are rounded and polished and often glazed by the deposition of a layer of silica or iron. They are hard and flinty, and testify to the intense silicification of the strata from which they were derived. Geologists hold that these stones are de-

rived from the cappings of Cretaceous sandstones, which apparently extended at one time over a much greater area than at the present day.

In the neighbourhood of the Grey Range the gibbers are limited in extent and were nowhere observed to extend over such boundless wastes as described by various writers for the central, more desert regions of Australia (Spencer and Gillen, 1912; Jack, 1915; Howchin and Gregory, 1909). They are found covering slopes and bases of low hills and extend for limited distances onto the plains. Yandama, on the western fringe of the Range, gives noteworthy evidence of this formation.

Another physiographic evidence of aridity in the Grey Range is to be found in the occurrence of certain salts in the soil. Gypsum deposits are frequent and fragments of crystalline gypsum are commonly found amongst the gibbers and on the rubble slopes.

Saline lakes occur to the west of the Range and increase in number as one passes across the South Australian border into true Desert Country. Lake Frome, Lake Callabonna and, to the north-west, Lake Eyre are the most important of these lakes. Travertine also occurs in the range, constituting a kind of hard pan some slight distance beneath the surface soil.

Climate.*

Rainfall.

The Grey Range is situated in the most arid portion of New South Wales, in fact the plains upon its western and north-western flanks fringe the most arid portion of Australia—the Lake Eyre basin. Yandama, on the western side of the Range, has an average annual rainfall of 6.55 inches, while Oodnadatta, in the Lake Eyre basin, has 4.85 ins.

The monthly average distribution of rainfall is only available for two stations in the Grey Range, Milparinka and Tibbooburra, and is shown in Table I.

Table I.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Milparinka	.96	.55	.72	.59	.67	.88	.47	.46	.44	.64	.67	.73	7.73
Tibbooburra	.74	.97	.85	.50	.46	.98	.52	.48	.49	.64	.78	.90	8.82

From this table, it will be seen that, although there is a fair degree of uniformity throughout the year, the average is highest for the summer months (November to February). It seems highly probable too, that if more data were available, particularly from the northern end of the range, the average for the summer months would be still higher. The position of the Grey Range is such that it receives some rain from the southern region of winter rain control and some from the region of summer rain control. This results in a degree of seasonal uniformity, but at the same time is responsible for the extreme variation in rainfall total. The following table indicates the extent of this variation.

* For meteorological data used in this paper the writer is indebted to Mr. Mares, Weather Bureau, Sydney.

Table II., showing variation in total rainfall for stations in the Grey Range, New South Wales.

Station.		Rainfall in inches.	Year.
Yandama	Highest	16.20	1890
	Lowest	2.38	1905
Milparinka	Highest	18.13	1885
	Lowest	2.18	1888
Tibbeoburra	Highest	17.42	1887
	Lowest	1.88	1919

A feature of the rainfall in the Grey Range, in which this Range resembles the Barrier and other arid regions in Australia, is that a certain percentage of the rain falls in small amounts, from .10 to .25 inch. If, as is often the case, these small falls are followed by intensely hot dry days, then it is only reasonable to suppose that a large amount of this water is lost by evaporation before it can be made use of by the plants.

Dr. Cannon (1921, p. 67) observed at Leigh's Creek and other stations in South Australia that fine soil is moistened to a depth of 4 cm. by a rain of .21 inch, while a coarser soil is penetrated to a depth of 8-9 cm. He shows further that "given favorable soil conditions, a rain amounting to .20 inch, penetrates the soil sufficiently to moisten the horizon occupied by the roots of many annuals and also by a portion of the horizontal roots of certain perennials."

In addition to small falls of rain, this country is one characterised by severe thunderstorms, often local in nature, during which several inches of rain may fall.

During the writer's recent visit to Yandama in October, 1922, 1.25 inch fell in one fall after a drought of two years. Later, during December, 1922, falls of seven, eight and ten inches were recorded from various localities in the Grey Range within a few days.

Heavy and soaking rains which can penetrate the hard baked surfaces of clay, and can percolate through the more heated upper layers of the sandy soil, are apparently the only rains which affect the larger perennial plants with their more deep-seated root systems.

Evaporation and temperature.

There is no information available concerning evaporation in the Grey Range, but, judging from the rate at which the water dries in the clay pans and water-holes after rain, the amount of evaporation must be considerable. According to the mean evaporation map for Australia (Cannon, 1921, p. 26) the north-west corner of New South Wales, including the Grey Range, comes between the 90 and 100 inch lines.

Temperature records are also meagre, but, if records for Tibbooburra may be taken as typical for the Range, the average may be regarded as from 69° to 70°. Table III. shows the monthly averages in temperature for Tibbooburra.

Table III.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Tibbooburra	83.9	83.0	76.3	68.3	59.8	54.2	52.4	57.2	63.4	70.0	76.5	82.8

The highest shade temperature recorded for Tibbooburra is 115° and the lowest in the same year 28° giving a range of 87° F.

Previous Investigations.

Until the present time, our knowledge of the plants and their relationships in the Grey Range has been very meagre and confined almost entirely to the botanical notes made during Sturt's Exploring Expedition to the interior in 1844-1845 (Sturt, 1849). More recently Dr. W. MacGillivray referred to various species collected in the Grey Range and its neighbourhood while on a journey to Cooper's Creek from Broken Hill (MacGillivray, 1923).

After leaving Flood's Creek, at the northern extremity of the Barrier Range, in the advance upon the distant Grey Range, Sturt and his party encountered sand ridge after sand ridge covered with pine trees. The red clayey flats between were clothed with "Salsolaceous plants." Sturt says of these ridges (1849, p. 184):—"The sand ridges, some partially, some thickly, covered with Pine-trees [*Callitris robusta* (?)] were from thirty to fifty feet high, and about eighty yards at their base, running nearly longitudinally from north to south. They were generally well covered with grass, which appeared to have been the produce of recent rains; and several very beautiful leguminous plants were also growing on them" [probably *Crotalaria, Swainsona, Clianthus, Indigofera,* etc.].

Later, when attempting to reach a hypothetical inland sea north-west of the Grey Range, Sturt is seriously hampered by these sandridges and exclaims—"Sandy ridges once more rose up in terrible array against us, although we had left the last full 50 miles behind, even the animals I think regarded them with dismay" (p. 378) . . . . "Here, on both sides of us, to the eastward and to the westward, they followed each other like the waves of the sea in endless succession, suddenly terminating as I have already observed on the vast plain into which they ran" (p. 380). Sturt records the occurrence of Acacias, Hakeas and Melaleucas on these ridges, but as he proceeds into the true desert country of the Lake Eyre basin, he finds the ridges bare but for the "porcupine" grass or "spinifex" (*Triodia irritans*) and an occasional "species of *Mesembryanthemum* with light pink flowers on a slender stalk" (p. 405), by which he probably meant *Calandrinia Balonensis* (Portulacaceae). Sturt refers frequently to the slopes of the Grey Range covered with quartz rubble and to the gibber sheets, which he describes as being bare of timber. An outstanding feature of his narrative from the botanical point of view is his reference to pine thickets and pineries on sandridges north of the Barrier Range and in the neighbourhood of the Grey Range.

There is no doubt that by the pine Sturt referred to *Callitris robusta* or some species of *Callitris.* Since the pine is almost absent from these ridges at the present day and is only represented by scattered groups in both Barrier and Grey Ranges (Collins, 1923, p. 262) Sturt's botanical notes describing conditions of nearly 80 years ago, have an added interest.

Investigations of arid regions in South Australia, where physiographic and climatic conditions are somewhat similar to those described by the writer for the Grey Range, have been carried out in recent years by Dr. Cannon (1921) and by Osborn and Adamson (1922). Physiographically the Grey Range and its neighbourhood approximate more closely to the Oodnadatta region (Cannon, 1921) in that gibber slopes and plains with sparse vegetation and sand ridges and claypans constitute extensive habitats. A difference exists, however, in that the scrub vegetation of the sand ridges near Oodnadatta is more open and contains fewer species than near the Grey Range in New South Wales.

Osborn and Adamson (1922, p. 543) describe a luxuriant sandhill vegetation for the Ooldea region in South Australia. Although Ooldea is situated just within

the 10-inch isohyet and, consequently, the scrub vegetation in this locality contains a wider range of species than observed by the writer in north-western New South Wales, the observations of these writers upon developmental relationships of the vegetation bear out, to a certain extent, those already made by the present writer in arid New South Wales (Collins, 1923).

The Plant Habitats.

As in the case of the Barrier Range, there are certain fairly well defined habitats in the Grey Range and its neighbourhood. The most important of these are the rocky hills and slopes, the sandy plains and the creek beds.

The rocky hills and slopes are of two distinct types—the slate and claystone deposits making up the greater part of the Range, and the lower hills and slopes which are covered for the main part by gibbers and rubble. The sandy plains are either level stretches of sand dotted with clay-pans, or they are thrown up into a corrugation of sand ridges. The latter are rarely colonised as thickly as the sandy plains and possibly indicate less beneficial water relations. Where the lower slopes of the range merge into the plains, the latter are covered with sheets of rubble and gibbers. These sheets are in process of formation and represent primary bare areas within the plains. They are almost destitute of tree and shrub vegetation and, on account of the heat reflected from the polished surface of the stones, these gibber slopes and plains represent a most inhospitable habitat for the invasion and establishment of seedlings. However, miniature depressions occur in the gibber sheets, and, since these represent centres of small localised drainage systems, they have naturally become centres of colonisation after rains.

The claypans are a consistent feature of flat sandy country throughout arid and desert Australia. They vary considerably in size, ranging from a few yards to over a mile in diameter. In outline the pans are sometimes circular, but more often irregular. Neighbouring pans often merge into one another, owing to the sweeping away, by wind, of the intervening barrier of sand. In some cases there is hardly any boundary delimiting the claypans from the surrounding plains and in these cases the pans tend to become buried in sand drift. In other cases a rim of sand is built up round the pan, the water-carrying capacity of which is thereby increased. Tate and Watt (1896, p. 23) offer the following suggestion to account for the origin and formation of claypans. "They naturally occur only where the country is flat. . . . . There is, therefore, a tendency for the water to lie on the surface or rather to be gathered into slight depressions, which are sure to exist even on otherwise almost level surfaces. At first the water that was gathered into these slight depressions would almost immediately percolate the porous strata, but in doing so it would leave behind a deposit of silt. This would happen with every subsequent heavy fall of rain, until the silt suspended in the water and carried into the depression and deposited there, was in sufficient quantity to prevent further percolation. The claypan has now become established, and will retain water for a longer or shorter period, and as there is now very little percolation through the bottom there will be no further settling of the floor as there may have been in the early stages."

It is possible that many of the claypans originate in the manner described above; others perhaps are formed by the removal of sand from the clayey substratum, which is known to lie close to the surface in some localities at least, and the subsequent holding of water in these clayey areas.

Surrounding the larger claypans there are definite zones subjected to flooding.

These are known as "box" flats, since they are colonised by the box, *Eucalyptus bicolor* (Collins, 1923, Plate xxii.).

The sandy creek beds are colonised by box (*E. bicolor* and *E. microtheca*) and river red gums (*E. rostrata*), species of *Acacia* and other small trees and shrubs. It is on these water-courses that the only tall tree vegetation of the region is found.

The Vegetation of the Rocky Hills and Slopes.

As has been shown above, the rocky hills and slopes are of two main types, those which are made up of slatey deposits, and those where the surface soil is covered with a rubble of quartz fragments or with a mosaic of gibbers. In either case these slopes are but sparsely timbered. The slate outcrops bear an open vegetation of scattered bushes and small trees, all of which are represented in the scrub flora of the sandy plains to be described later. Species of *Acacia* such as *Acacia aneura* F.v.M., *A. tetragonophylla* F.v.M. and *A. cana* Maiden are frequently found with scattered species of *Eremophila* (*E. Latrobei* F.v.M., *E. Sturtii* R.Br., *E. maculata* F.v.M., *E. latifolia* F.v.M., *E. Freelingii* F.v.M., etc.) and *Myoporum deserti* A. Cunn. The vegetation on slate outcrops was nowhere observed by the writer to form a thick scrub. At the time of the writer's visit to the Grey Range during a period of drought (Oct., 1922) the ground between the small trees and bushes was practically bare, except for low bushes of *Kochia* and *Atriplex* and the withered remains of grasses and annuals of a previous rainy season. Although the open nature of this vegetation is no doubt due in part to the practice of grazing and the non-establishment of perennials during extended droughts, it is highly probable, in the case of the slate outcrops at least, that edaphic factors affect the general configuration of the flora to a large degree. Osborn's observations upon the vegetation of the slate outcrops in the Mt. Lofty Ranges near Adelaide (Osborn, 1914) and those of the writer in the Barrier Range (Collins, 1923) give support to this view. Where the rainfall is great enough to ensure the growth of grasses, as near Adelaide, a grassland results. In such a climate as that of the Grey Range, however, where rain is periodic and scanty at best, the ground flora, when present, is made up chiefly of species of Chenopodiaceae (*Atriplex, Kochia, Rhagodia, Bassia*) and such annuals as are commonly found on the plains belonging to the Compositae, Leguminosae, Cruciferae, Gramineae, etc.

The quartz rubble slopes are generally bare except for a few species of Chenopodiaceae such as *Bassia brachyptera* * and other species of *Bassia*. In one locality near Mt. Poole, a rubble and gibber slope is being colonised by a community of the leafless Asclepiad *Sarcostemma australe* R.Br., the so-called "caustic bush" or "snake-bush" of stockmen (Plate v., Photo 4).

Gibber slopes are devoid of tree and tall shrub vegetation except in the neighbourhood of creeks, where certain shrubby species often extend up the slopes from the creek beds. In several localities *Acacia Cambagei*, the "gidgee' (Plate v., Photo 6), has spread over gibber slopes to form dense scrubs. The usual appearance of a gibber slope, however, is that of a barren sheet of stones, unrelieved by any tall vegetation. A stunted form of *Atriplex vesicarium* colonises gibber slopes and plains extensively and represents the sole vegetation for many miles (Plate v., Photo 5). Where the gibber sheets are characterised by the de-

* Formerly *Kochia brachyptera* F. v. M.

pressions referred to above, small centres of colonisation occur and patches of annual vegetation are found. The withered remains of *Bassia brachyptera* were observed by the writer in all these depressions, the species representing again the pioneer coloniser on rubble slopes and plains (Collins, 1923, p. 253).

Such annuals as *Helipterum floribundum* DC., *H. polygalifolium* DC., *Myriocephalus Stuartii* and the grasses *Astrebla pectinata* F.v.M. (Mitchell Grass), *Iseilima Mitchelli* Andr. (Flinders Grass) and *Andropogon sericeus* R.Br. (Blue Grass) are frequently found in these depressions. These latter are good standing grasses, and represent important additions to the flora for summer grazing. An interesting addition to the tree vegetation of the rocky outcrops of the Grey Range is the blood-wood *Eucalyptus terminalis* F.v.M., which occurs on the sandstones near Tibbooburra. This is the only species of *Eucalyptus* in the neighbourhood of the Grey Range, which grows away from creek beds or flooded flats.

The Vegetation of the Sandy Plains.

The vegetation of the sandy plains and sand ridges in the neighbourhood of the Grey Range is considerably more dense than that of the rocky outcrops described above. In fact, if one were to look out, from some elevated point in the range, over the surrounding country, one would see monotonous miles of dense grey-green scrub rolling away to the horizon. Occasional open spaces, practically devoid of trees and tall shrubs, point to the effects of grazing and clearing. The trees and shrubs making up this vegetation are distinctly xerophilous. The canopy or umbrella form of branching as seen in *Acacia* and *Eremophila* is common, the leaves are either hard and leathery, with a marked development of sclerenchyma and with thick cuticles, or they are characterised by the secretion of a layer of resin over the surface (e.g., *Eremophila* spp. and *Dodonaea*). Leaves and phyllodia are commonly strap-shaped and are generally arranged parallel to the incident rays of light. Partial or total aphylly is sometimes found as in *Casuarina* and *Exocarpus*. Although there are no truly deciduous types in this region, it frequently happens that certain Leguminous plants shed their pinnae or leaflets and become phyllodineous (e.g. *Acacia* and *Cassia*). An interesting case of the shedding of lateral leaflets occurs in *Crotalaria Cunninghamii* R.Br., where the two lateral leaflets are shed soon after the opening of the leaf, the broad terminal leaflet remaining. In this manner certain plants diminish their transpiring surface, and are thereby better fitted to withstand the intense heat and desiccating winds of summer. Species of *Acacia* e.g. *Acacia tetragonophylla*, shed their phyllodes during prolonged droughts, further production of phyllodes taking place with the coming of rain. As has been shown above, the sandy plains are thrown up in certain areas into a corrugation of sand ridges which succeed one another for many miles and are separated by clay flats of varying width. As a general rule the vegetation of these ridges is not so dense as that of the level sandy plain. This may be due to the less stable condition of the sand ridges or perhaps, in part, to their lower water-capacity. Small sand ridges are pioneered by clumps of *Salsola Kali* followed, after rain, by various annual Chenopodiaceae such as *Atriplex holocarpum* F.v.M., *A. halimoides* Lindl., *A. angulatum* Benth., *A. campanulatum* Benth., *A. limbatum* Benth., *A. fissivalve* F.v.M., *A. Muelleri* Benth. Other annuals appearing during the early colonisation of sand are various Composites such as *Myriocephalus Stuartii* Benth., *Helipterum floribundum* DC., *H. strictum* Benth., *H. polygalifolium* DC., also *Blennodia canescens* var. *pterosperma*, *Solanum ellipticum* R.Br., *S. esuriale* Lindl. and many others. Amongst

the perennials, *Acacia ligulata* is frequently found during the early stages of development and is generally associated with the small Leguminous shrub *Crotalaria dissitiflora*. The long golden-flowered racemes of this latter plant bring a prodigal wealth of colour to the parched sand ridges. Although the early stages of colonisation of sand are only observable upon small recently formed ridges, it is probable that plant succession is the same for both sandy plain and sand ridge. Where open areas occur on sandy plains, owing to scrub-cutting and burning, and partly to the eating out of perennial seedlings by rabbits and sheep, a community of *Atriplex vesicarium* (Plate vii., Photo 11) or *Kochia sedifolia* is often found, *K. pyramidata, K. aphylla* and *Rhagodia spinescens* being occasionally associated with the former. Annuals, chiefly belonging to the Compositae, Leguminosae, and Gramineae, together with a variety of small herbs, enter the scrub in these open spaces. It has apparently been the policy of pastoralists to cut and clear scrub, in order to increase the area occupied by the saltbushes and annual herbage, and, as a result, at the present day, large open areas of saltbush country occur in the scrub. The scrub, which is apparently the climax vegetation for the region, is characterised by small trees and tall shrubs, with an undergrowth of smaller shrubs, and a groundflora of the smaller woody perennials and numerous annuals.

In general character, this association closely resembles the "mulga" scrub described for the rocky hills and slopes of the Barrier Range (Collins, 1923). There are minor differences, however, in that certain species are represented in the one locality and not in the other, and certain species which are dominant in the one locality are but sparingly represented in the other.

The mulga, *Acacia aneura* (Plate viii., Photo 14) is still the dominant species of the scrub association. With *Acacia aneura* and often assuming the role of co-dominant, are *Acacia tetragonophylla, A. cana, A. ligulata, A. Murrayana* (Plate vi., Photo 10), *A. Oswaldi, A. stenophylla, A. Burkitti*, and *A. rigens*. Amongst the trees of the association, perhaps the most important are *Casuarina lepidophloia* (Casuarineae) *Myoporum platycarpum* and *Eremophila longifolia* (Myoporineae) *Grevillea striata* (Plate vi., Photo 8) and *Hakea leucoptera* (Proteaceae), *Santalum lanceolatum* and *Exocarpus aphylla* (Santalaceae) *Atalaya hemiglauca* (Sapindaceae), *Owenia acidula* (Meliaceae) and *Pittosporum phyllyraeoides* (Pittosporaceae). Of these species, *Atalaya hemiglauca* and *Owenia acidula* were not observed by the writer in the Barrier Range, but as these are known to have extended down the Darling River and to the east as far as the Cobar district, it is possible that outlying individuals do occur in the Barrier Range, although they cannot play as important a part in the scrub association as they do in the neighbourhood of the Grey Range. *Atalaya hemiglauca* generally grows in groups of from four to six individuals. This is due to vegetative propagation from horizontal roots, a common feature of plants in these regions. *Hakea leucoptera* is of lower stature here than observed in the Barrier Range and is generally characterised by the "mallee" habit, three or four stems taking the place of the main central stem. This adoption of the mallee habit is of interest, since *Hakea leucoptera* is known to store water in similar manner to the various species of mallee (*Eucalyptus oleosa, E. incrassata* Labill. var. *dumosa* F.v.M., etc.). Apart from the trees enumerated above, the mulga scrub is largely made up of shrubs of varying size. Of these the Myoporineae, Leguminosae and Sapindaceae play an important part. Of the Myoporineae *Myoporum acuminatum, M. platycarpum* and *M. deserti* are frequently found while *Eremophila Duttoni, E. Sturtii, E. Latrobei, E. longifolia, E. alternifolia, E. oppositifolia* and *E. Brownii* are com-

mon members of the scrub. Rarer species of *Eremophila* are occasionally met in groups of a few individuals such as *Eremophila bignoniflora* and the almost leafless *E. polyclada* (Plate vi., Photo 9).

Of the Leguminosae, species of *Cassia* are second in importance to the *Acacias*. *Cassia Sturtii, C. eremophila,* and *C. artemisioides* are again prominent, but *Cassia phyllodinea* increases in number of individuals as we proceed north from the Barrier Range, until, in the neighbourhood of the Grey Range, it is the most abundant species. *Cassia pleurocarpa* is recorded by MacGillivray (1923, p. 140) for sandy country in the Grey Range, though it was not collected by the writer. *Templetonia egena, T. aculeata* and *Crotalaria dissitiflora* are further Leguminous plants entering into the undergrowth. *Crotalaria Cunninghamii,* with its large green flowers, is an interesting addition to the scrub flora, but is more often found on open sandy ridges. This species is characterised by trifoliate leaves, the two lateral leaflets of which are shed at an early stage. Of the Sapindaceae, in addition to *Atalaya hemiglauca* (the white wood) referred to above, *Dodonaea viscosa, D. viscosa* var. *spathulata, D. attenuata* and *Heterodendron oleaefolium* are important species. The latter often occurs in dense "mono-specific" communities (Plate vii., Photo 12) and forms scrubs similar to those made by the various species of *Acacia*.

An undergrowth of lower woody and herbaceous perennials is a characteristic feature of the scrub vegetation. Amongst the most important of these are *Ptilotus obovatus* and *Ptilotus nobilis* (Amaranthaceae), *Atriplex vesicarium, Kochia sedifolia* and *Rhagodia spinescens* (Chenopodiaceae), *Sida virgata* and *Lavatera plebeia* (Malvaceae), *Solanum Sturtianum* (Solanaceae), *Scaevola spinescens* (Goodeniaceae), *Senecio magnificus* and *Senecio Gregorii* (Compositae).

Open areas in the scrub are generally occupied almost exclusively by members of the Chenopodiaceae and after rains by a large additional flora of annuals. This annual flora resembles that described for the Barrier District (Collins, 1923), and it is possible that most of the species recorded for that region are found in the Grey Range. The Compositae make up a great part of this annual flora, species of *Helichrysum, Helipterum, Myriocephalus, Angianthus, Minuria* and *Brachycome,* being important. Such Leguminous plants as *Clianthus Dampieri* (Sturt's Desert Pea), *Swainsona procumbens, S. tephrotricha, Psoralea eriantha,* and the trailers *Indigofera brevidens* and *Glycine clandestina* are perhaps second in importance to the Composites amongst the annual flora.

According to the time of the year in which the great part of the rain falls, a winter or summer herbage develops. Since the Grey Range is close to the southern boundary of the summer rain controls it is usual for more rain to fall during the spring and summer months. This results in the development of a grass herbage mixed with annual salt bushes. The Mitchell Grass (*Astrebla pectinata* F.v.M.), the Flinders Grass (*Iseilima Mitchelli* Andr.) and the Blue Grass (*Andropogon sericeus* R.Br.) are the most important of these grasses, species of *Stipa, Danthonia, Neurachne* and *Aristida* also occurring.

It is possible that a fairly large grass flora develops in the Grey Range and its neighbourhood after rains, but it is only the good standing grasses which remain with the onset of the drying winds so prevalent in these parts.

Amongst the winter herbage are various species of Cruciferae such as *Blennodia canescens* R.Br., *Blennodia lasiocarpa* F.v.M., *B. nasturtioides* Benth., *Stenopetalum lineare* R.Br., *Lepidium papillosum* F.v.M., *Sisymbrium* sp., *Portulaca oleracea* and *Calandrinia Balonensis* are important members of this herbage

owing to their water storage capacity and their consequent ability to persist through the hot weather of early summer. *Erodium cygnorum* (the crowfoot), *Daucus brachiatus* (the wild carrot) and *Didiscus glaucifolius* (the wild parsnip) are further members of the winter herbage.

The Vegetation of the Claypans, Creek Beds and Flooded Flats.

As in the case of the claypans described for the Barrier District (Collins, 1923, p. 257) early colonisation takes place by species of *Babbagia* and *Bassia*, with *Chenopodium nitrariaceum* on the outer limits. In the region of the Grey Range, claypans which have been dry for some time are commonly colonised and often completely reclaimed by the Cane-grass *Glyceria ramigera* (Plate viii., Photo 16).

The sandy creek beds are again conspicuous as bearing the tallest trees of the region, the River Red gums (*Eucalyptus rostrata*) (Plate ix., Photo 18) and the "box" (*Eucalyptus microtheca*). With *Eucalyptus rostrata* and *E. microtheca* smaller trees and tall shrubs often occur. These are the Whitewood, *Atalaya hemiglauca, Owenia acidula, Pittosporum phyllyraeoides* and various species of *Acacia, Eremophila* and *Myoporum*. *Acacia Cambagei*, the Gidgee, often constitutes the entire vegetation along minor creek channels. This forms dense thickets for some distance on either side of the creeks (Plate ix., Photo 17).

The flooded areas on either side of creeks and minor drainage channels and the flats surrounding the larger claypans are often covered by a dense growth of the leafless *Muehlenbeckia Cunninghamii*, the so-called "lignum." This occurs with the "black box," *Eucalyptus bicolor*. The groundflora of such flooded regions closely resembles that described for the Barrier District, the species being practically identical. Wet soil is colonised by the small stocky Composite, *Centipeda thespidioides*, and by *Marsilia Drummondii* ("Nardoo") and *Marsilia exarata, Mimulus repens, Morgania glabra, Lavatera plebeia*, together with many Composites, Gramineae, and Chenopodiaceae occupy the drier land. *Nitraria Schoeberi* is again common on flooded land and the Amaryllid, *Crinum flaccidum*, appears to reach its maximum development in these parts (Collins, 1923, p. 260).

General Discussion.

As has been shown above, the Grey Range and its neighbourhood differ from the Barrier District in certain geologic and physiographic features. The fact, that the Grey Range comes within the region previously capped by the great Cretaceous sandstone series, has resulted in the formation of gibber slopes and plains, due to the weathering and wind-polishing of these sandstones. The barrenness of such areas gives ample evidence of their inhospitality as a plant habitat.

The abundance of slates and claystones in the rock formation of the Grey Range is probably responsible, in part, for the open nature of the vegetation and the absence of thick scrub on the rocky hills and slopes, such as is found on the Willyama Series of the Barrier Range. On the other hand, a comparatively luxuriant vegetation is developed on sandy plains in the neighbourhood of the Grey Range. Although sandhill and claypan country is found in the Barrier District, it appears to reach its maximum development to the north-west of the Grey Range. It was here that the sand ridges and sandy plains with their dark gloomy scrub filled Sturt and his band of explorers with dismay.

From the description given, in the present paper, of the vegetation of these sandy plains, it will be seen that, in general configuration, this vegetation resembles

the mulga scrub previously described for the Willyama Series in the Barrier district. Minor differences occur, however, in that certain species recorded for the Grey Range were not previously met in the Barrier district. The most important of these are *Atalaya hemiglauca, Owenia acidula, Eremophila bignoniflora, E. polyclada* and *Acacia Farnesiana.* Again, certain species, which were abundantly represented in the scrub of the Barrier district such as *Fusanus acuminatus* and *F. persicarius* (Santalaceae) were not observed by the writer in the scrub of the Grey Range, and are probably absent from this region. *Santalum lanceolatum,* on the other hand, is a more prominent member of this latter scrub. The scrub of the sandy plains near the Grey Range apparently represents the climax vegetation for the region. The mulga, *Acacia aneura,* is still the dominant species over wide areas, though other species of *Acacia* such as *Acacia Cambagei* and *A. cana* become dominant in places and form dense scrubs.

This vegetation, to which the term *Acacia Steppe* may be applied, doubtless represents the climax vegetation at the present day for all country in New South Wales west of the River Darling, that is, country with an average annual rainfall of from 6 to 10 inches. Observations upon succession in the Grey Range and its neighbourhood, bear out those already made in the Barrier district. Bare areas, whether of primary or secondary origin, are first colonised by members of the Chenopodiaceae. In the case of secondary bare areas within the scrub association, communities of *Atriplex, Kochia* and *Rhagodia* are commonly found. Primary bare areas, such as rubble slopes and gibber sheets, are colonised in the first instance by *Bassia brachyptera* and *B. divaricata,* followed later by other species of *Bassia, Kochia* and *Atriplex.* Other primary bare areas such as claypans are first invaded by species of *Bassia* and *Babbagia,* while minor drainage channels are first colonised by annual species of *Atriplex.*

In general configuration the scrub association of the Grey Range and its neighbourhood resembles that of the Barrier district. "Monospecific" communities are again a characteristic feature of the vegetation as is also the sporadic occurrence of small groups or isolated communities. The pine, *Callitris robusta,* is represented sporadically in this locality where at one time it formed dense pineries (Sturt, *loc. cit.*). As far as the writer is aware, *Acacia Farnesiana* is represented by a solitary group of individuals a little south of Milparinka. In the western portion of the region, that approximating more closely to desert conditions, certain species are met which, according to the writings of other investigators (Cannon, 1921, Osborn and Adamson, 1922), appear to reach a greater development in more desert regions.

The "mallee" (*Eucalyptus oleosa*) which occurs in pockets or "inliers" throughout the Barrier district is no longer a member of the scrub vegetation in these parts.

A feature worthy of note in the far north-west of New South Wales, and one observed by the writer in the Barrier district also, is the apparent failure of natural regeneration of certain woody perennials. The mulga, *Acacia aneura,* being one of the most important woody fodder plants of arid and semi-arid New South Wales, naturally comes under closer observation than other woody perennials. During the investigations of the writer, which were carried out over two years, and over a strip of country over 300 miles in length, in no instance were seedling plants of *Acacia aneura* observed. The general consensus of opinion amongst old residents in these parts seems to indicate that crops of seedlings of

Acacia aneura are rare, and that when these do appear, the plants rarely reach maturity.

It is known that many woody perennials of arid regions are able to rejuvenate and produce more individuals by means of suckers from horizontal roots. The apparent failure of regeneration of *Acacia aneura* should give grave cause for alarm where this species is an important fodder reserve and where grazing is carried out, at best, under most adverse circumstances.

To make better use of our desert fringe as a grazing region it is important to know the factors affecting the establishment and development of the mulga (*Acacia aneura*). The fact that this species is dominant in the scrub association at the present day indicates that conditions were more favourable in the past for its establishment. We have evidence to show that prolonged droughts have killed large communities of woody perennials in arid New South Wales and that the mulga has suffered in this way. There is no doubt that recurrent droughts seriously affect the amount of seed produced and the number of seedlings eventually established of any species in these parts.

The relative capacities of the seedlings of woody perennials to withstand drought seems to the writer to merit special attention in arid New South Wales.

In addition to the recurrence of droughts as affecting the establishment of seedlings of woody perennials, and of *Acacia aneura* in particular, in arid New South Wales, the biotic factor is of importance. Rabbits cause extensive damage in western New South Wales by ringbarking seedlings and young plants of woody perennials, and by creating large secondary bare areas in the scrub around their burrows. Overstocking of runs and continued browsing down of seedlings by stock no doubt play an important part in causing the failure of natural regeneration and in retarding natural development of communities. To what extent the vegetation of western New South Wales has been affected by these factors in the past cannot now be estimated, but we are in a position to state that, at the present day, the natural balance of vegetation is being seriously disturbed by these agencies.

In conclusion, it seems to the writer that strict supervision of western lands is necessary in order to check retrogression of vegetation, and the consequent encroachment of desert conditions upon what is now shrub-steppe.

Summary.

1. Geological, physiographic and climatic features of the Grey Range and its neighbourhood are briefly dealt with.
2. Plant habitats are described, such as rocky hills and slopes, "gibber" and quartz rubble sheets, sandy plains, sand ridges, claypans, creeks and flooded flats.
3. An account of the vegetation of these habitats is given, attention being paid to early colonisation of bare areas and evidence of succession.
4. The nature of the groundflora in reference to summer and winter rain controls is briefly dealt with.
5. **In a general discussion, the developmental aspect of the vegetation is dealt with and reference made to the apparent failure of natural regeneration of certain woody perennials.**
6. **Evidence shows that *Acacia Steppe* is the climax vegetation in New South Wales at the present day for the 6-10 inch rainfall belt; and further, that a certain amount of deterioration is going on within this formation due to biotic and climatic factors.**

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*Appendix.**

List of Plants collected in the Grey Range and its neighbourhood in September and October, 1922.

Marsilea Drummondii A.Br.
M. exarata A.Br.
Callitris robusta R.Br.
Spinifex paradoxus Benth.
Aristida calycina R.Br.
Stipa elegantissima Labill.
S. setacea R.Br.
S. scabra Lindl.
Danthonia penicillata F.v.M.
Astrebla pectinata F.v.M.
Triodia irritans R.Br.
Glyceria ramigera F.v.M.
Iseilima Mitchelli Andr.
Andropogon sericeus R.Br.
Crinum flaccidum Herb.
Bulbine semibarbarta Haw.
Casuarina lepidophloia F.v.M.
Grevillea stenobotrya F.v.M.
G. striata R.Br.
Hakea leucoptera R.Br.
Exocarpus aphylla R.Br.
Santalum lanceolatum R.Br.
Loranthus exocarpi Behr.
L. Preissii Miq.
L. miraculosus Miq.
L. Quandong Lindl.
Muehlenbeckia Cunninghamii F.v.M.
Rhagodia spinescens R.Br.
Chenopodium nitrariaceum F.v.M.
Atriplex vesicarium Hew.
A. holocarpum F.v.M.
A. halimoides Lindl.

* This list is, no doubt, incomplete, particularly as far as annual species are concerned, since the writer visited the locality after an intensely dry season.

A. angulatum Benth.
A. Muelleri Benth.
A. limbatum Benth.
A. fissivalve F.v.M.
Bassia diacantha F.v.M.
B. paradoxa F.v.M.
B. biflora F.v.M.
B. bicornis F.v.M.
B. quinquecuspis F.v.M.
B. longicuspis F.v.M.
B. divaricata F.v.M.
B. bicuspis F.v.M.
B. lanicuspis F.v.M.
†*B. brachyptera* (F.v.M.)
Kochia brevifolia R.Br.
K. pyramidata Benth.
K. aphylla R.Br.
K. sedifolia F.v.M.
Enchylaena tomentosa R.Br.
Arthrocnemum arbuscula Moq.
Salsola Kali L.
Babbagia dipterocarpa F.v.M.
B. acroptera F.v.M.
Ptilotus obovatus F.v.M.
P. nobilis F.v.M.
Alternanthera triandra Lam. var. *nodiflora* F.v.M.
Tetragonia expansa Murr.
(*Aizoon quadrifidum*)
Gunniopsis quadrifida (F.v.M.) Pax.
Portulaca oleracea L.
Calandrinia balonensis Lindl.
Blennodia trisecta Benth.
B. lasiocarpa F.v.M.
B. nasturtioides Benth.
Stenopetalum lineare R.Br.
Lepidium papillosum F.v.M.
L. fasciculatum.
Tillaea recurva Hook.
Pittosporum phyllyraeoides DC.
Acacia tetragonophylla F.v.M.
A. rigens A. Cunn.
A. sentis F.v.M.
A. gladiiformis A. Cunn.
A. Murrayana F.v.M.
A. Cambagei R. T. Baker.
A. Oswaldi F.v.M.
A. stenophylla A. Cunn.
A. Burkitti F.v.M.
A. aneura F.v.M.
A. Farnesiana Willd.
A. cana Maiden.
A. Loderi Maiden.
A. ligulata ?.
Cassia pleurocarpa F.v.M.
C. phyllodinea R.Br.
C. eremophila A. Cunn.
C. Sturtii R.Br.
C. artemisioides Gaud.
Templetonia aculeata Benth.
T. egena Benth.
Crotalaria Cunninghamii R.Br.
C. dissitiflora Benth.
Lotus australis Andr.
Indigofera brevidens Benth.
I. australis Willd.
Psoralea eriantha Benth.
P. patens Lindl.
Clianthus Dampieri A. Cunn.
Swainsona tephrotricha F.v.M.
S. phacifolia F.v.M.
S. procumbens F.v.M.
Glycine clandestina Wendl.
Erodium cygnorum Nees.
Linum marginale A. Cunn.
Zygophyllum apiculatum F.v.M.
Z. iodocarpum F.v.M.
Z. fruticulosum DC.
Tribulus terrestris L.
Nitraria Schoeberi L.
Owenia acidula F.v.M.
Euphorbia Drummondii Boiss.
E. eremophila A. Cunn.
Atalaya hemiglauca F.v.M.
Heterodendron oleaefolium Desf.
Dodonaea viscosa Jacq.
D. viscosa var. *spathulata* Benth.
D. attenuata A. Cunn.
Abutilon sp.
Lavatera plebeia Sims.
Sida virgata Hook.
S. corrugata Lindl.
Cienfuegosia gossypioides Hochr.
Pimelea simplex F.v.M.
P. petrophila F.v.M.
Eucalyptus bicolor A. Cunn.

† Formerly *Kochia brachyptera* F. v. M.

E. microtheca F.v.M.
E. rostrata F.v.M.
E. terminalis F.v.M.
Melaleuca trichostachya Lindl.
Didiscus glaucifolius F.v.M.
Daucus brachiatus Sieb.
Jasminum lineare R.Br.
Sarcostemma australe R.Br.
Convolvulus erubescens Sims.
Heliotropium curassavicum L.
Lappula concava F.v.M.
Rochelia maccoya F.v.M.
Solanum esuriale Lindl.
S. ellipticum R.Br.
Nicotiana suaveolens Lehm.
Mimulus gracilis R.Br.
Morgania glabra R.Br.
Myoporum deserti A. Cunn.
M. platycarpum R.Br.
M. tenuifolium var. *acuminatum* R.Br.
Eremophila oppositifolia R.Br.
E. Sturtii R.Br.
E. Latrobei F.v.M.
E. longifolia F.v.M.
E. bignoniflora F.v.M.
E. polyclada F.v.M.
E. Brownii F.v.M.
E. Duttonii F.v.M.
E. maculata F.v.M.
E. alternifolia R.Br.
Cucumis sp.
Isotoma petraea.
Wahlenbergia gracilis A. DC.
Goodenia sp.
Scaevola spinescens R.Br.
Minuria integerrima Benth (Candollei F.v.M.).
Calotis hispidula F.v.M.
Myriocephalus Stuartii Benth.
Angianthus pusillus Benth.
Craspedia globosa Benth.
C. chrysantha Benth.
Helichrysum apiculatum DC.
Helipterum polygalifolium DC.
H. floribundum DC.
H. strictum Benth.
Senecio Gregorii F.v.M.
S. magnificus F.v.M.
Centipeda thespidioides F.v.M.

DESCRIPTION OF PLATES IV.-IX.

Plate iv.

1. Western fringe of Grey Range at Yandama, N.S.W. Creek in foreground with *Eucalyptus microtheca* (box), *Atalaya hemiglauca* (Whitewood) and *Acacia Cambagei* extending up rubble slopes.
2. Low hills of Grey Range from Mt. Poole. Quartz rubble in foreground sloping to Evelyn Creek (Box and Gum).
3. Vertical slate outcrop at Sturt's Depot Glen, Mt. Poole.

Plate v.

4. Gibber and rubble slope colonised by community of *Sarcostemma australe.*
5. Gibber slope with community of *Atriplex vesicarium,* Yandama.
6. Gibber slope near Yandama Creek, with *Acacia Cambagei* as sole timber.

Plate vi.

7. Open scrub near Mt. Arrowsmith, with emus in foreground. *Myriocephalus Stuartii* making up groundflora; *Eremophila Sturtii* at side and *Acacia aneura* in distance.
8. *Grevillea striata* (the beefwood) on sandy plain west of Yandama.
9. *Eremophila polyclada* (?) on clayey flat, Grey Range.
10. *Acacia Murrayana* on sandridge north west of Grey Range. *Triodia irritans,* the "porcupine" grass or "spinifex" constituting the only ground flora.

Plate vii.

11. Open sandy plain with community of *Atriplex vesicarium.*
12. Sand ridge west of Grey Range with "monospecific" community of *Heterodendron oleaefolium.*

13. *Heterodendron oleaefolium* on sandy rise near Yandama, showing exposure of roots by wind erosion.

Plate viii.

14. Mulga scrub (*Acacia aneura*) on sand ridge west of Grey Range.
15. Part of a claypan bordered by open saltbush plain with *Atriplex vesicarium* and *Kochia sedifolia*. Colonisation of pan by *Glyceria ramigera* has commenced.
16. Claypan reclaimed by *Glyceria ramigera*.

Plate ix.

17. *Acacia Cambagei* in creek bed, Mt. Poole, Grey Range.
18. *Eucalyptus rostrata* in Yandama Creek.

AUSTRALIAN COLEOPTERA—NOTES AND NEW SPECIES NO. iii.

By H. J. Carter, B.A., F.E.S.

(Ten Text-figures.)

[Read 26th March, 1924.]

The following notes are the outcome of my recent visit to the British Museum of Natural History and to the Hope Museum. There are added descriptions of two new genera of Buprestidae, with two and three new species respectively; two new genera of Tenebrionidae, of which one belongs to a subfamily (Heterotarsinae) not hitherto recorded from Australia and which is apparently closely allied to a North American genus; and a few new species that recent investigations show to be undescribed.

BUPRESTIDAE.

My revision of the genus *Stigmodera* (Trans. Roy. Soc. S. Aus., 1916) should be corrected as follows:—

Stigmodera cyaniventris Kerr. = *S. variabilis* Don.

S. viridicincta Waterh. var. = *S. carpentariae* Blkb.

The latter species was omitted from my list of synonyms by accident. Blackburn's type is almost identical with the specimen marked *viridicincta* var. by Waterhouse, the type itself being an unusual form of a fairly common North Queensland species.

S. major Waterh. is a variety of *pubicollis* Waterh., as stated by its author, and not as in my tabulation under *parryi* Hope.

S. aeneicornis Saund. is a distinct species *not* synonymous with *rotundata* Saund., and should stand in my table near *disjecta* Kerr. (No. 215).

S. deleta Kerr. is a distinct species, not a variety of *mastersi* Macl.; Kerremans labelled every example of a species he described as "type" and, in some cases, two different species are marked with identical labels, e.g., of two specimens labelled "*inermis* Kerr. type," one is a *distincta* Saund, the other is *nova* Kerr.).

S. pallidipennis Blackb. is a small example of *auricollis* Thoms.

S. addenda Kerr. (*nom. praeocc.* by Thomson) = *straminea* Macl.—a common form of this species without the lateral maculae; later also described by Théry as *S. johannae.*

S. septemguttata Waterh. = *tyrrhena* Blackb., a variable species in which the fasciae are often broken up into spots. (Types compared). Waterhouse's name has priority.

S. anchoralis C. and G. = *agrestis* Kerr.

S. rubriventris Blackb.—The type of this was described from Western Australia and is *not* the species usually labelled in Australian collections under that

name, which is a well-known Eastern species (N.S.W.) described as *maculifera* Kerr. (erroneously given in my tabulation as a synonym of *rubriventris*).

S. simulata C. and G. = *perplexa* Hope = *lanuginosa* Hope. The last two of these were placed by Saunders as synonyms of *burchelli* C. and G., a mistake repeated by Masters.

S. hostilis Blackb.—An examination of the type has convinced me that this is a good species, with each elytron trispinose, and therefore is not synonymous with *burchelli* C. and G.

S. suavis Kerr. is only one of the many forms of *scalaris* Boisd. (= *cyanicollis* B.).

S. libens Kerr. (omitted from my tabulation, *vide loc. cit.*, p. 99) is synonymous with *alternecosta* Thoms.

Stigmodera praeterita, n.sp.

♂. Elongate, oblong; head, pronotum, scutellum, underside and legs dark brassy-green or black, the pronotum with yellow margins, antennae green; elytra yellow, sometimes clouded (by the darkening of the striae and seriate punctures); the apical three-quarters of suture dark green, or bluish; this dark part widening anteriorly and towards apex, to a variable degree; apical segments of abdomen sometimes yellow at sides. *Head* channelled and coarsely punctate. *Prothorax* depressed, strongly bisinuate at apex and at base, anterior angles acutely produced, base with wide medial lobe, angulately excised near the yellow margin; sides straight (parallel or slightly obliquely widening) on basal half, thence rather abruptly narrowed to apex, posterior angles rectangular; disc finely and evenly punctate (without a sign of rugosity), the medial channel smooth and very clearly defined. *Elytra* sub-parallel on basal two-thirds, thence rather sharply attenuated to apex, and not quite covering the abdomen; apices variably bidentate, a strong sutural tooth obliquely directed inwards, and an external tooth (unusually variable in length), the interspace arcuate; disc striate-punctate, the punctures in striae irregular, intervals nearly flat, the interval between the 5th and 6th striae wide and coarsely punctate; underside sparsely clothed with long whitish hairs, finely and evenly punctured, the prosternum lightly transversely rugose, the last segment of abdomen widely excised.

♀ differs in the following: colour of head, prothorax, underside and appendages black (in two only of nine females examined green, while of the three males one had these parts black, the abdomen bluish, rarely greenish), the exterior apical spine of elytra short; apical segment of abdomen rounded. *Dimensions*: ♂ 26-29 x 9-10 mm.; ♀ 30-32 x 10-12 mm.

Hab.—New South Wales: Kuring-gai Chase and Mona Vale, on *Angophora cordifolia* (H. J. Carter). A species that has surprisingly escaped notice in a district that has been more closely collected than any in Australia. This is probably due to its superficial likeness in the field to some forms of *S. variabilis* Don, which also occurred in numbers at the time of its capture. In structure and sculpture it is very close to *S. affinis* Saund., as also in the arrangement of dark colour on the elytra; but besides the absence of any red colour on pronotum and elytra and the frequent black surface of body, it is differentiated from *affinis* by (1) the bispinose apices of elytra, (2) the strongly angulated baso-lateral excision of pronotum, (3) the sharper angles of pronotum. Twelve examples were taken during December, 1923, of which three only were males. Types in Coll. Carter.

Stigmodera affinis Saund.—The author states that "the puncturation of the thorax is larger and deeper" than in *S. limbata* Don. This is misleading, since

one of the main distinctions between these species lies in the evidently finer sculpture of *affinis,* from which the interpunctural rugosities which characterize the pronotum of *limbata* are absent. Also the "two apical segments spotted with red on the sides," is not a constant character.

STIGMODERA COMMIXTA, n.sp. (Text-fig. 1.)

Ovate; surface violaceous blue, the elytra with medial and sub-apical fasciae yellow, sometimes also with a small yellow spot near base at middle, *not extending to sides or base;* antennae bronze; tarsi greenish-bronze. *Pronotum* very convex, more sinuate at base than at apex, anterior angles acutely produced, sides widely rounded with greatest width near the middle, disc moderately punctate on basal half, closely so at apex. *Elytra* obovate, widened at shoulders and post-medially, hind margins finely serrated, apices with a small lunation without spines; disc striate-punctate, intervals convex, and coarsely punctate; underside finely and closely punctate with sparse, white pubescence. *Dimensions:* 15-18 x 6-8 mm.

Hab.—New South Wales: Sydney (G. S. Bryant and H. J. Carter). This is the species referred to in my Revision (p. 82) as a variety of *S. klugi* C. and G., but which, with more material, I am satisfied is a distinct species. While like *klugi* in general form and colour, the following differences may be tabulated:—

S. klugi (Text-fig. 2).	*S. commixta.*
Head with interocular space narrower and sub-parallel.	This area wider and diverging.
Prothorax, sides near base straight or slightly widening; widest behind middle.	More convex, sides widely rounded, widest near middle.
Underside strongly punctate.	More finely punctate.

There is also a slight colour difference in the more violet shade of *commixta,* and a tendency of the yellow fasciae to be little or not interrupted at the suture, as in *klugi.*

Fifteen examples of *klugi* and eight of *commixta* are before me, with both sexes of each. In both there is sometimes a basal yellow spot on the elytra as well as the two fasciae. In *klugi* eight (1 ♂, 7 ♀) have the basal spot as in Saunders' figure, extending from near the scutellum to the sides and base, seven (♂) are without it. The yellow fasciae are generally more widely interrupted at the suture than in *commixta.* In *commixta* four (2 ♂, 2 ♀) have a small spot half way between scutellum and sides, but in no case extending to base or sides; four (2 ♂, 2 ♀) are without it.

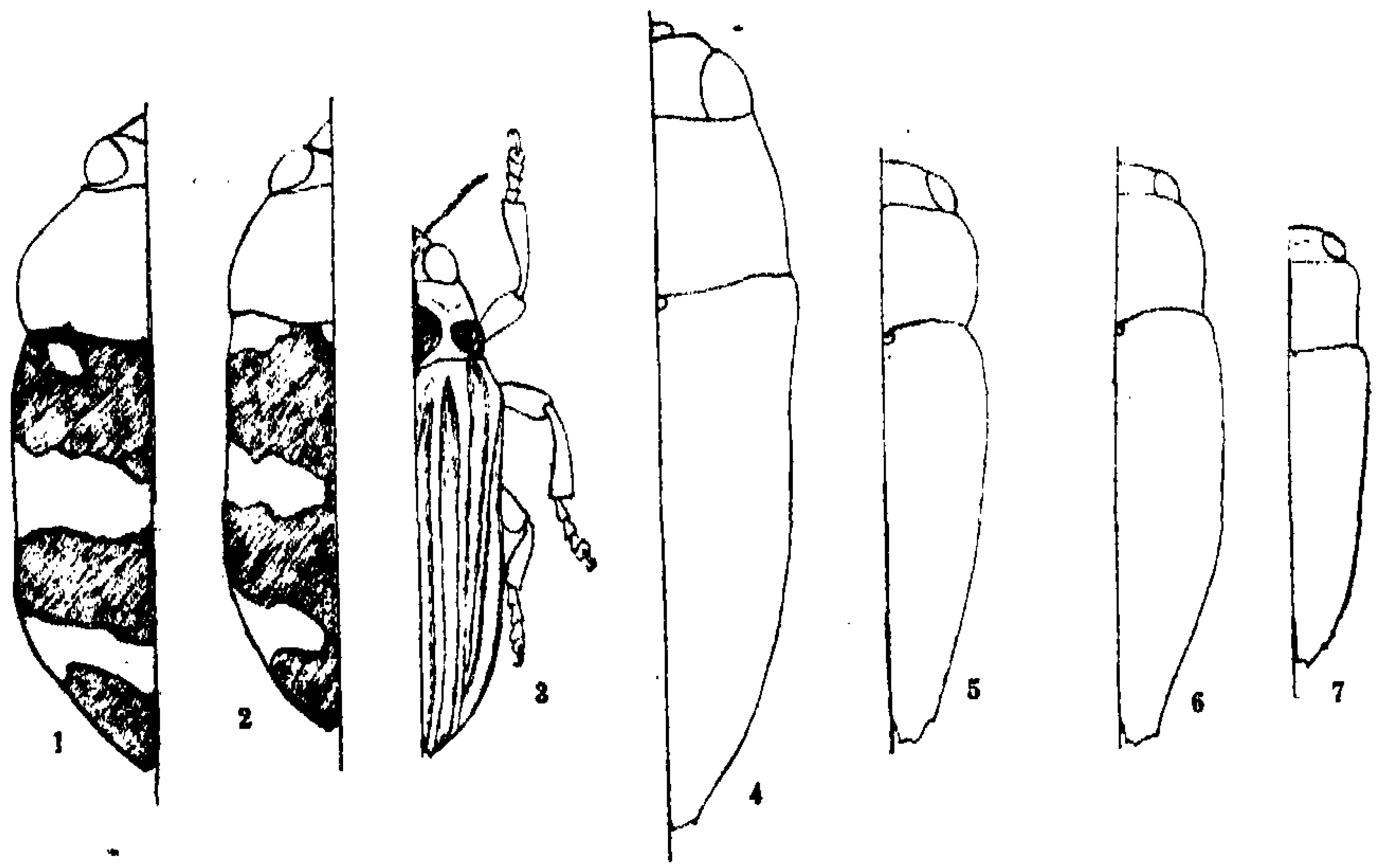
(*N.B.*—The sexes in both species are little differentiated by abdominal structure, the last segment being subtruncate in ♂, rounded in ♀). Type in Coll. Carter.

Stigmodera puerilis Kerr.—Amongst the vagaries of pattern variation in the genus, this species varies as follows: (1) The medial yellow fascia, usually divided at the suture, is connected and widened in that region, (2) the medial yellow fascia is not only connected at suture, but is extended to join the basal yellow spots. I have examples from the Dorrigo district, as well as five examples taken by myself at Gosford and Wahroonga, that show these variations.

STIGMODERA LATIPES, n.sp. (Text-fig. 3.)

Elongate oblong, rather flat; head, pronotum and scutellum bronzy-black, elytra red, underside blue-black; legs, tarsi and antennae black. *Head* prolonged in front, strongly punctate, deeply channelled between eyes. *Pronotum* bisinuate

at apex and base, anterior angles acute, sides nearly straight on anterior half; surface very uneven, with four prominent ear-like ridges, two on each lobe, the inner two enclosing a large oval fovea near base; the outer two forming a rounded extension at sides on basal half; medial channel deeply excised, the whole surface



Figs. 1-7.

1. *Stigmodera commixta.* 4. *Buprestodes coruscans.*
2. *Stigmodera klugi.* 5. *Notobubastes occidentalis*, ♂.
3. *Stigmodera latipes.* 6. *Notobubastes orientalis*, ♂.
7. *Notobubastes aurosulcata.*

closely punctate. *Elytra*: sides sharply rectangular at junction with pronotum, rather strongly widened at shoulder, lightly compressed at middle, rounded and minutely crenate behind; apices finely and inconspicuously bidentate; each elytron with three carinate costae, of which the two inner are parallel throughout, the exterior diverging at shoulder; the lateral border forming a fourth, besides two faint scutellary costae; the sutural edges also sub-carinate. Sternal area coarsely punctate, abdomen finely strigose-punctate, the apical segment densely and finely punctate; tibiae and tarsi unusually widened, the former flattened. *Dimensions*' 14 x 5 mm.

Hab.—New South Wales: Coonabarabran district (H. J. Carter). Two ♀ examples were taken by me on *Leptospermum* flowers at Timor, Warrumbungle Mountains, in November, 1923. The species belongs to my first section of the sub-genus *Castiarina*, "Elytra carinate costate," near *nasuta* Saund. and *spinolae* C. and G., but unmistakably distinct from these (and *praetermissa* Cart.) by elongate form, pronotal ridges and widened tibiae *inter multa alia*. Type in Coll. Carter.

Chalcotaenia martinii Saund. = *bi-impressa* Carter. The latter name must therefore disappear. Saunders' species was erroneously placed under *Pseudotaenia* by Kerremans, and this misled me. It is an anomalous species in that the medial line of the pronotum is raised apically while sulcate for the greater part. The prosternum is deeply sulcate. (Type examined).

Paracephala minuta Kerr. is evidently synonymous with *P. pistacina* Hope.

Nascio lunaris Kerr. is distinct from *vetusta* Boisd.

Euryspilus (*Eurybia*) *australis* Blackb.—This species is very doubtfully distinct from *E. chalcodes* C. and G. In examining a series of *E. chalcodes* taken at S. Perth on the same date and evidently conspecific, I notice differences of sculpture that correspond closely to Blackburn's differential character of *C. australis*. I think this difference is individual and may be sexual.

Anilara (*Melobasis*) *obscura* Macl. = *A. cuprescens* Kerr. = *A. uniformis* Kerr. = ? *A. platessa* Thoms.

I have already noted ("Revision of Melobasis," Trans. Ent. Soc. Lond., 1923, p. 70) the confusion of names *Anilara* (*Melobasis*) *obscura* Macl. and *Anilara* (*Anthaxia*) *obscura* Macl., and have proposed the name *A. macleayi* for the latter. A close inspection of Kerremans' types fails to show specific differences between his *cuprescens* and *uniformis*. Moreover, the locality, "Australie: Nouvelle Zélande" for *uniformis* requires confirmation. I have placed a query before Thomson's species, since the identification of his species is doubtful, though his name is general in collections for a common insect that is variable in size and that I have frequently secured by beating dead Eucalyptus boughs in New South Wales and Victoria. It is probable that *A. deplanata* Théry is the same species.

The genus *Anthaxia* does not, apparently, occur in Australia. The species described by Macleay as *Anthaxia* are referable either to *Anilara* or to *Melanophila*.

The genus *Anilara* is approaching the nebulous state that *Cisseis* was in. Six Australian species have recently been added by Théry (Mém. Ent. Soc. Belg., 1920) to the twenty so far recorded, but no one has been bold enough to attempt a tabulation of the genus.

Belionota saundersi Waterh. = *B. aenea* Deyr. = *B. carteri* Kerr. (MSS. ?).

Specimens from Cape York sent some years ago to Monsieur Kerremans were returned to me as *B. carteri* Kerr. sp. nov. I have no record of the publication of this name, but the species is certainly synonymous with *B. saundersi* Waterh., which I am unable to distinguish from a series labelled *aenea* Deyr. in the British Museum. Deyrolle's species has a long priority. In the Genera Insectorum, Kerremans gives Ile Damma as the habitat of *saundersi*, though the type came from Cape York, Australia.

Buprestodes (gen. nov. Buprestinorum).

Surface brilliantly metallic. Head lightly convex, front slightly flattened, not grooved; epistoma subangulately excised at apex; antennal cavities large and triangular, bordered above and below by prominent carina, open behind on margin of eye; antennae with first joint pyriform, 2nd, 3rd and 4th short and oval, successively increasing in length, 5th subconic, longer than 4th; 6th-11th dentate, each with a terminal poriferous fossette. Eyes large, elliptic, well separated, a little closer behind than in front. *Prothorax* sub-trapezoidal, sides feebly arched, lateral border sub-crenulate with ill-defined carina, apex feebly sinuate, anterior angles slightly advanced and acute; base bisinuate, with wide medial lobe and subacute posterior angles. *Scutellum* small, rounded and bilobed (or longitudinally cleft). *Elytra* moderately convex, sides lightly compressed and subangulately lobed in front of middle; posterior sides not denticulate, each apex truncate between two spines, the exterior spine the longer; disc coarsely striate-punctate, intervals varyingly convex. Prosternal process forming a bisulcate tongue. Basal segment of abdomen sulcate; hind tarsi with three basal joints subequal, fourth

short and bilobate, claw joint longest of all. Facies of *Chalcotaenia*. *A genus apparently near Melobasina, of which, however, the pronotum has a straight anterior margin; the posterior sides of elytra denticulate, apical abdominal segment of male trifid inter alia.*

BUPRESTODES CORUSCANS, n.sp. (Text-fig. 4.)

Robust, glabrous, upper surface brilliant golden copper, intermixed with green, the latter colour showing chiefly on head, sides of pronotum and humeral area of elytra; beneath fiery coppery, antennae greenish-coppery, tarsi metallic green.

Head: labrum prominent and rectangular, forehead coarsely longitudinally rugose-punctate. *Prothorax* irregularly and coarsely punctate on disc, rugose-punctate on sides, an irregular smooth line on basal half at middle, and a few irregularly placed smooth areas elsewhere. *Elytra* coarsely striate-punctate, with about ten convex intervals of darker colour than the rest of elytra, narrowing and subcrenulate towards apex and sub-obsolete near base, the 1st, 3rd and 5th of these having irregularly spaced, fiery spots containing punctures, the punctures in striae large and irregular. *Prosternum* very coarsely punctate, its intercoxal process having a small convex area in middle, with a deep, punctate sulcus on each side of this; abdomen glabrous, irregularly punctate, basal segment sulcate in middle, apical segment finely rounded behind. *Dimensions*: 21-22 x 7-8 mm.

Hab.—Western Australia: Doverin and Kellerberrin (Mr. J. Clark). Two examples, both female, of this fine species, at first suggest inclusion among the Chalcophorini, but the structure of antennae and prothorax point to its place in the tribe *Buprestini*, though unlike any other Australian genus of this group.

Male wanting. Type in Coll. Carter.

BUPRESTODES VARIEGATA, n.sp.

Differs from the above species as follows: Head, prothorax, sides of elytra, underside and legs metallic green, the prothorax showing a few coppery areas at base and underside; middle area of elytra violet coppery, antennae and tarsi dark coppery.

Pronotum clearly carinate in middle on basal half. *Elytra* more regularly striate-punctate, without the irregular fiery areas on intervals; the large punctures in the 4th, 5th and 6th striae containing smaller punctures within. The prosternal tongue with setiferous punctures on middle convexity, the two punctate sulci finer and narrower; basal segment of abdomen longitudinally rugose, other segments coarsely punctate, the sides of meso- and metasternum, also of abdomen, clothed with fine, recumbent, golden hairs; apical segment sub-truncate, with projecting aedeagus. *Dimensions*: 19 x 6 mm.

Hab.—Western Australia: Kellerberrin. A single male example, also sent by Mr. J. Clark. This, when further material is available, may prove to be the male of *B. coruscans*, but apart from colour differences, the different sculpture of elytra, prosternum and abdomen justify its distinction until further evidence arrives. The head and pronotum of the two species are similar, the elytra are narrower and more sharply attenuated behind. The three examples noted above are the only specimens I have seen.

Female wanting. Type in Coll. Carter.

NOTOBUBASTES (gen. nov. Buprestinorum).

Antennae and antennal cavities as in *Bubastes*; eyes large, prominent, widely separated and nearly parallel. *Prothorax* shorter and less convex than in

Bubastes, apex subtruncate; the anterior angles a little produced, lateral carina more or less continuous on basal two-thirds, not visible from above; base strongly bisinuate, disc sulcate in middle. *Scutellum* tranversely oval, moderately large. *Elytra* wider and less convex than in *Bubastes*, apices tridentate, posterior sides not serrated, surface striate-punctate; posterior tarsi with first joint clearly longer than the second.

A genus having a facies somewhat between *Bubastes* and *Melobasis*; differing from the latter in apical structure and the non-serrate elytra and from *Bubastes* in its wider, more explanate form, larger and more prominent eyes, larger scutellum, etc.

NOTOBUBASTES OCCIDENTALIS, n.sp. (Text-fig. 5.)

Elongate, subconical, unicoloured, dark purple bronze, head and underside sparsely and shortly pilose, beneath more nitid than above. *Head* lightly impressed, with a short carina in middle (near epistoma) and some vaguely raised spaces on each side of this forming a discontinuous oval; antennae short and as in *Bubastes*. *Prothorax* (3½ x 5 mm.): anterior angles feebly advanced, base rather strongly bisinuate, sides lightly incurved near apex and base nearly straight in middle; anterior angles obtuse, posterior subrectangular; disc coarsely rugose-punctate; medial sulcus rather wide with fine clear-cut line at its base, the sides with a few nitid pustules and sparse hair. *Scutellum* transverse, depressed in middle. *Elytra* roundly widening behind junction with prothorax, thence subobliquely narrowed to apex; apices tridentate, with a sharp sutural, a blunted medial, and a sharp externo-lateral tooth, the two last separated by a wide sinuous interval; striate-punctate, the striae clearly impressed on apical half, on basal half obscured by coarse punctures with flat transversely rugose intervals, the apical intervals between striae themselves containing punctures of the same size as striae, the 2nd, 4th, 6th more closely punctate than the rest; underside coarsely punctate. *Dimensions*: 16-17 x 5½-6½ mm.

Hab.—Western Australia: Cue (H. W. Brown). Four examples in my collection were collected by Mr. Brown who appears to have taken it in some quantity. The sculpture of the elytra is closely punctured everywhere with large punctures. These show clear longitudinal arrangement, with well-marked striae and convex intervals near apex, but the tendency of the punctures to form transverse ridges becomes more marked towards the middle; and these ridges gradually obscure the striae near base. The lateral margin is finely carinate; that is traceable to near the apex, without distinct serration. The sexes are little separated by external structure, the abdominal apical segment being shorter and truncate in ♂, rounded in ♀.

Types in Coll. Carter.

NOTOBUBASTES ORIENTALIS, n.sp. (Text-fig. 6.)

Elongate ovate, pronotum and elytra metallic purple, the former sometimes bronzy, head and underside bronze, sparsely albo-pilose, tarsi, antennae and front side of legs brownish purple. *Head* coarsely punctate, a depression above epistoma limited by an irregularly raised triangular margin, having its apex about the middle of forehead; antennae short and slender. *Prothorax* convex, feebly sinuous at apex, the middle slightly gibbous and advanced, base lightly bisinuate, sides moderately and evenly rounded, the angles slightly produced, the anterior obtuse, the posterior subrectangular, disc finely sulcate in middle, coarsely rugose-punctate, the punctures sparse on middle, especially near scutellum, rugose on sides, the

lateral carina interrupted or undulate, traceable only near base. *Scutellum* bright coppery, less transverse than in preceding. *Elytra* slightly wider than prothorax at base, sides a little compressed near middle, attenuate behind, margins entire, apices tridentate, sutural tooth short and acute, middle and lateral wide, their interspace wide and substruncate; sulcate-punctate throughout, each elytron with ten sulci, the 10th on side; the punctures in sulci small, intervals convex, sharply so near apex, each with a row of widely placed punctures and transversely rugose near shoulders and sides; legs and underside very coarsely punctate, abdomen with longitudinal punctures irregular in size. *Dimensions*: 15-17 x 5½-6 mm.

Hab.—Queensland: Dawson River and Wide Bay (Macleay Mus.). Four examples, including the types, in the Macleay Museum, are clearly distinct, though closely allied to the former species. The chief distinctions are (1) brighter colour of, and more nitid, upper surface, (2) pronotum more coarsely sculptured, with more smooth spaces, (3) elytral intervals convex, (4) apices subtruncate between external spines.

NOTOBUBASTES AUROSULCATA, n.sp. (Text-fig. 7.)

Elongate oblong, dark purple bronze, pronotum reddish bronze, its medial sulcus metallic golden, head and underside rather thickly clothed with white recumbent hair. *Head*: Eyes prominent, smaller than in *N. occidentalis;* interspace wider than diameter of an eye, interior margins of eyes slightly converging behind, forehead lightly gibbous, surface coarsely rugose. *Prothorax* (2 x 3 mm.): apex subtruncate, the anterior angles slightly advanced, base lightly bisinuate, the posterior angles rectangular, sides nearly straight on basal two-thirds, thence roundly narrowed to apex, medial sulcus deep, limited by a short transverse ridge at basal margin, the sulcus accentuated by a slight gibbosity on each side, this portion nitid and sparsely pitted with round punctures of irregular size; towards the sides coarsely transversely rugose and pilose. *Scutellum* small, transversely oval. *Elytra* enlarged at shoulders, feebly narrowed behind, apices tridentate, the middle tooth the most prominent, striate-punctate, each elytron with 10 fine, well-marked striae, besides a short scutellary stria, each containing rows of close small punctures; intervals flat on medial area, lightly convex at sides and apex, a single row of large round metallic punctures on each interval, these irregularly placed (sometimes invading the narrow striae), humeral area and sides transversely ridged; epimera and metasternum with sparse, coarse punctures, mesosternum albo-floccose, abdomen pilose with a few large punctures showing near margins of segments. *Dimensions*: ♂. 11 x 3½ mm. ♀. 13 x 4 mm.

Hab.—North West Australia: Hammersley Range, Fortescue River (W. D. Dodd). Three examples from the South Australian Museum are near, but distinct from *N. occidentalis* by smaller, narrower form, sulcate pronotum with its irregular surface and sparser punctures, and the different elytral sculpture. The metallic pronotal sulcus and elytral punctures are also characteristic of this species.

Types in South Australian Museum.

ETHON LEAI, n.sp.

Narrowly ovate, head and pronotum bronze, elytra purplish, above sparsely, beneath more densely pubescent. *Head* sharply and deeply intersected between eyes. *Prothorax* widely transverse, strongly bisinuate at apex and base, sides arcuately converging to the front, disc subconcentrically striolate, with a few scratch-like punctures in middle area, depressed laterally, the depressed and medial areas sparsely pubescent. *Scutellum* large and triangular. *Elytra* seriate-

punctate, the serial punctures fine and close, interspaces closely covered with a minute transverse rugosity; a thin white pubescence extending in two wide lines on middle of each elytron from base to apex, this vaguely sub-fasciate towards apex. Prosternum rather coarsely punctate, rest of underside finely scalose-punctate with moderate pubescence. *Dimensions*: ♂. 5.5-6 x 2-2.3 mm. ♀. 7 x 2.5 mm.

Hab.—South Australia (Meadows. In South Australian Museum), Nariootpa (J. G. O. Tepper). Ten examples examined are somewhat like small examples of *E. affinis* C. and G., but may be distinguished by the rugose elytra, and the sub-continuous elytral pubescence, as well as by its small size. *E. brevis* Cart. is a wider species with coarser seriate punctures and bifasciate pubescence.

Type in South Australian Museum.

CISSEIS VIRIDI-PURPUREA, n.sp.

Oblong oval. Head, pronotum, underside and appendages golden-green or green, elytra bright purple, the elytra scarcely, the underside *not* pubescent. *Head* nearly flat, finely channelled, vertex closely, not very finely, punctate. *Prothorax*: apex lightly produced in middle, base strongly bisinuate, sides arcuately narrowed from base to apex, lateral carinae subparallel, anterior angles acute, posterior obtuse, disc transversely depressed near base, with fine transverse striolation. *Scutellum* transversely oval. *Elytra* lightly enlarged at shoulder, separately rounded at apex, the apical margins finely serrated; a little gibbous behind scutellum, the surface finely and regularly covered with scale-like punctures. *Prosternum* coarsely, meso- and meta-sternum moderately, abdomen finely and closely punctate. *Dimensions*: 5 x 2 mm.

Hab.—Western Australia: Geraldton (J. Clark); Victoria and Australia (Coll. Théry). Four examples examined, of the same size and of closely similar colour, of which two in my collection had hitherto been withheld from description as being possible forms of *C. tyrrhena* mihi. The two further examples occur in a collection sent for determination by Mons. André Théry. The species cannot be matched with any that I have seen. While in colour like some examples of *tyrrhena*, it is without the pubescent spots of that species, besides being smaller and more bluntly oblong, among other differences.

I am not quite sure whether it should be placed in Sect. ii. or Sect. iii. of my tables, since the elytral pubescence is so feeble as to be faintly discoverable, with a Zeiss binocular, only in one of the four examples. If placed in Sect. iii., it should come between *roseo-cuprea* Hope and *minutissima* Thoms.; distinguished from both by its bicolorous upper surface.

Type in Coll. Carter.

CISSEIS CUPRIPENNIS Guér.—By inadvertence this species was omitted from the tables in my Revision of the Genus, though mentioned in the introduction (p. 161). It is one of the species in which there is sex colouration, the males having a green head and pronotum, the females a more or less concolorous surface. The amount of elytral pubescence, always slight, depends on the freshness of the specimen; it is often found in collections without pubescence. Its place should be in Sect. ii., Group B., p. 165, between *acuducta* Kirby and *scabrosula* Kerr., which may be tabulated thus:—

8. Rather widely oval, elytra nitid, underside pubescent (8-10 mm.) .. .. *acuducta* Kirby

9a. Narrowly oval, nitid above and below (6-8 mm.), male with head and pronotum green. . . . . *cupripennis* Guér.
9b. Elytra with opaque, subcyaneous patch. . . . . *scabrosula* Kerr.

AGRILUS DODDI, n.sp.

Head a fiery copper, pronotum and elytra subnitid coppery bronze with patches of silvery pubescence as follows: the side of pronotum, a circular patch within the humeral foveae, a premedial comma-like patch on each side of suture, and a pair of similar but more elongate pre-apical patches close to suture, the last merging into the fine, close pubescence of the apical third area; underside albo-squamose, showing coppery gleams where abraded: appendages coppery.

Head not wider than prothorax, feebly excavate between eyes, the latter not prominent, densely and finely punctate. *Prothorax*: apex feebly, base strongly bisinuate, sides nearly straight; disc transversely rugose; a large medial triangular, and a lateral elongate depression. *Scutellum* triangular. *Elytra* with a large sub-circular fovea at shoulder, lightly concave on each side of suture, the concavity limited by a feeble ridge traceable from near the premedial pubescence to near apex; apices separately rounded and finely denticulate; surface with a fine scalose derm showing pubescence towards sides and apex. *Dimensions*: 9 x 2.5 mm.

Hab.—Queensland: Townsville (F. P. Dodd). A pair long since obtained from the famous naturalist to whom it is dedicated is apparently undescribed and absent from the British Museum collections. The pale pubescence occupies depressions and makes a faint pattern, unlike that of other known Australian species.

Type in Coll. Carter.

AGRILUS BISPINOSUS, n.sp.

Head and pronotum metallic greenish-copper, the former fiery copper on front, the latter with a large reniform patch of golden flocculence filling the lateral depressions; elytra, underside and appendages dark blue or blue-black, the first with two small medial golden pubescent spots situated on the concave area, one on each side of suture, and two preapical more elongate and nearer the suture than the former two; the prosternal episterna and four large patches on abdomen also with golden flocculence (two on the exposed dorsal surface at the lateral medial expansion, and two on sides of 3rd ventral segment, continued on dorsal area).

Head sharply excavated and channelled between eyes, the frontal area somewhat elevated above the eyes with a marked lateral carina; eyes large and prominent, extending laterally beyond the apex of prothorax, finely rugose punctate. *Prothorax*: apex feebly, base strongly bisinuate, sides nearly straight, slightly narrowing from base to apex, sides with a large deep circular, depression not extending to base, a large medial depression not quite extending to apex and widening near base, surface transversely rugose. *Scutellum* triangular, its fore part transversely carinate, depressed behind. *Elytra* slightly wider than prothorax, the humeral callus forming the extension of longitudinal ridge traceable to apex and produced behind into two sharp spines, base foveate within humeral ridge, subsutural concavity evident from near middle to apex, the suture itself carinate; apices denticulate on each side of spines. Underside lightly punctate. *Dimensions*: 11 x 3 mm.

Hab.—Queensland: S. Johnstone River (H. W. Brown). A single specimen received from its captor is unlike any described Australian *Agrilus*, though ap-

proximating the former species (*A. doddi*), from which it differs widely in ground colour, underside, and form, especially as to apex of elytra.

Type in Coll. Carter.

N.B.—*Agrilus flavotaeniatus* Thoms. is evidently a form of the wide-spread *A. australasiae* C. and G.

The following list contains the previously described Australian species:

1. *australis* Thoms.
2. *aurovittatus* Hope.
3. *australasiae* C. and G.
   hypoleucus C. and G.
   assimilis Hope.
   purpuratus Hope.
   flavo-taeniatus Thoms.
4. *deauratus* Macl.
5. *frenchi* Blackb.
6. *mastersi* Macl.
7. *nitidus* Kerr.
8. *terrae-reginae* Blackb.
9. *zonatus* Kerr.

AGRILUS SEMIVIRIDIS, n.sp.

Head, pronotum, basal half of elytra, legs and antennae emerald green, apical half of elytra bronze, the bronze continued also narrowly along sides to shoulders; suture near apex narrowly bordered with whitish villose clothing; underside bronze, sometimes green on sternal areas. *Head* minutely rugose, furrowed on vertex only; antennae extending considerably beyond the head. *Prothorax*: apex a little advanced in middle, base lightly bisinuate, sides sinuously widened at base, thence subparallel, or lightly converging to apex, a short lateral carina on basal half; posterior angles subacute, medial furrow well-marked throughout, widening towards base, disc transversely striolate. *Elytra* at shoulders slightly wider than prothorax, sides compressed behind shoulders, sharply attenuated towards apex, each elytron separately convex and the suture carinate on apical half, each apex separately, but rather finely rounded, not serrate, underside minutely punctate. *Dimensions*: 3.5-4.5 x 1-1.5 mm.

Hab.—Queensland: Cairns (H. Dodd), Johnstone River (H. W. Brown); New South Wales: Tweed River (W. W. Froggatt). Eleven examples of this pretty little species under examination; it is apparently not uncommon. A pair examined by Mr. K. G. Blair were labelled as "resembling *A. semi-aeneus* Deyr.," a species described from Borneo. The following characters from Deyrolle's description are inconsistent with identity: (1) greater size (6½ x 1¾), (2) Elytra "armeés chacune d'une longue épine," (3) "dessons vert doré brillant." Of these (2) seems decisive.

Type in Coll. Carter.

AGRILUS NIGRITUS Kerr.—Specimens from the S. Johnstone River, Queensland, taken by Mr. H. W. Brown were compared with Kerremans' type in the British Museum and found to be inseparable from it. The type was described from Banguey, an island north of Borneo.

AGRILUS BREVIS, n.sp.

Concolorous, brownish-bronze, glabrous, pronotum more nitid than elytra; rather wide and flat. *Head* finely rugose, widely furrowed throughout, eyes large and prominent, antennae short, scarcely extending beyond head. *Prothorax* transverse, lightly advanced in middle at apex, base lightly bisinuate, sides nearly straight, lateral carina very short, extending less than half-way from the posterior angle; this rectangular; disc with large foveate depression near middle at base and two latero-basal depressions; surface with fine transverse striolations. *Elytra*

of same width as prothorax at base, lightly compressed behind shoulders, moderately attenuated behind, each apex separately rounded, without serrations; surface with scale-like punctures. Epipleurae coarsely and closely, abdomen very finely punctate. *Dimensions*: 4 x 1.5 mm.

Hab.—Queensland: Johnstone River (H. W. Brown). Two examples examined are shorter, wider and less convex than other species of *Agrilus* known to me, but I cannot specify any structure that is inconsistent with its generic classification.

Type in South Australian Museum.

SYNECHOCERA Deyr.—So far, two Australian species have been described: *S. elongata* Thoms. and *S. tasmanica* Théry. I think I have determined Thompson's insect in specimens from South and Western Australia in the Adelaide Museum. Macleay's *Aphanisticus occidentalis* is another species and probably my *A. albo-hirtus* is a fourth, but I have no example at hand for examination. The genus is characterized by a flat, elongate, subparallel form, elytra rounded behind, and by an abnormal structure of the sternum. The antennae are toothed from the 5th segment. Three new species are described below.

APHANISTICUS Latr. belongs to another group of the Agrilini (Trachytes) characterized by a convex body, attenuated behind, tarsi short, the antennae having the apical three or four joints forming a club. Four species have been catalogued: *canaliculatus* Germ., *lilliputanus* Thoms., *occidentalis* Macl., and *albo-hirtus* Cart. Of these, the first is synonymous with *Paracephala pistacina* Hope, the second is a mystery, but will probably prove to be a *Germarica*, while, as stated above, the last two should be, I consider, referred to *Synechocera*. If I am correct in this, the two described below are the only known Australian species.

SYNECHOCERA CYANEIPENNIS, n.sp.

Elongate-oblong, depressed, subnitid; head, pronotum and underside black, elytra a rich violet blue, antennae reddish. *Head* bulbous, divided medially by a deep, narrow sulcus, eyes occupying almost whole side of head, but only a narrow section visible from above; front pitted with large shallow punctures, antennae short, the last four segments serrate. *Prothorax* transversely oval and flat; apex rather strongly advanced in middle; anterior angles unseen from above; base strongly bisinuate, the middle lobe widely rounded and deep, posterior angles widely obtuse; sides arcuately and strongly widening to near apex, then somewhat abruptly narrowed and depressed; a horizontal explanate margin throughout; disc with a longitudinal, oval depression occupying a large part of medial area, the whole disc minutely and densely striolate. *Scutellum* transversely triangular, punctate. *Elytra* rounded and widened at shoulders, sides parallel, apices separately rounded, a narrow, black, horizontal margin extending from base to apex, this margin narrowed and sub-carinate at base; whole surface pitted with large shallow punctures on a minutely rugose or striolate ground; a sub-obsolete ridge faintly seen, extending from humeral region along middle of each elytron. Underside glabrous and nearly impunctate. *Dimensions*: 4 x 1 + mm.

Hab.—Queensland: Atherton (A. M. Lea). Six examples of this pretty little insect, taken by Mr. Lea from a shrub (unspecified), are the only specimens I have seen. The pronotum at its widest is at least as wide as, or slightly wider than, the elytra.

Type in South Australian Museum.

SYNECHOCERA SETOSA, n.sp.

Elongate, cylindric, black, clothed above and below with short white setae. *Head* sub-bilobate, widely excavated and deeply channelled. *Prothorax* clearly wider than head, lightly bisinuate at apex, strongly so at base, sides moderately rounded, widest at middle, all angles bluntly rounded off; disc without fovea, a medial line indicated only by absence of setae in one example. *Elytra* more than three times as long as prothorax and of about the same width as it; very slightly compressed in middle, apices separately rounded; surface irregularly and closely scaly-punctate throughout, each puncture bearing a short recumbent hair. Abdomen clothed with longer hairs. *Dimensions*: 4-5 x 1-1¼ mm.

Hab.—Swan River, W.A. (Mr. J. Clark). Two examples generously given me by the captor show a species distinct from *occidentalis* Macl. by its excavate head, its much narrower prothorax and the absence of elytral ridge. *A. albo-hirtus* Cart. is bronze, with a convex forehead, the sides of prothorax subsinuate behind, hind angles sub-explanate, the elytral apices forming a single curve, etc.

Type in Coll. Carter.

SYNECHOCERA (?) CUPRIPES, n.sp.

Very elongate and narrow; head, antennae, sternum and legs metallic coppery (head, antennae and tibiae greenish-coppery) abdomen bluish, pronotum and elytra blue-black. *Head* very wide, eyes large and prominent, forehead moderately excavated and finely channelled and punctate. *Prothorax* of same width as head at apex, gradually narrowing to base, sides nearly straight, apex strongly bisinuate, base quadrisinuate—the middle lobe itself bisinuate to receive the scutellum; disc very uneven, a large elongate oval fovea on front half (framed in front by medial extension), a transverse depression on basal half, enlarged triangularly in middle, the apex of triangle near basal margin of pronotum, and again enlarging on sides, thus leaving two oblique raised areas near base; the raised portions of disc nitid and impunctate, the rest very finely punctate like the head. *Scutellum* transverse, oval. *Elytra* of same width as prothorax at base, and three and a half times as long; compressed in middle, apices widely and separately rounded off showing serrations on rounded margins and a short external tooth on each. Surface finely scaly-punctate and setose, with fine and close white hairs along medial area, a feeble ridge running obliquely from shoulders towards middle, thence parallel to suture and obsolete towards apex. Underside minutely punctate and setose. *Dimensions*: 7 x 1¼ mm.

Hab.—Queensland (Mr. H. W. Brown) and Cairns (A. M. Lea and A. P. Dodd). Five examples examined may ultimately be found to need generic distinction. The narrow, compressed form, especially of the elytra, suggests the genera *Macrones* and *Enchoptera* of the Cerambycidae. The sub-trapezoidal pronotum with its uneven surface, its attenuate form and dentate apices separate it from other Australian species, though showing some affinity with *S. albo-hirtus* Cart. in the form of head and prothorax.

Type in Coll. Carter.

APHANISTICUS ENDELOIDES, n.sp.

Elongate, subcylindric, nitid bronze. *Head* elongate, glabrous and minutely punctate with deep triangular cleft; extending on the upper surface for two-thirds of its length, eyes rather flat on the outside of the cuneate lobes formed by the cleft, a short sulcus at the base of each lobe; antennal cavities very closely set on each side of the pointed and triangular epistomal process, the antennae at rest

lying alongside this and extending but a short distance (¼) of the prothorax, the last 3 joints of antennae lamellate. *Prothorax* trapezoidal, apex and base nearly equally wide and wider than the head, apex truncate, base strongly bisinuate, sides moderately rounded with greatest width in front of middle, narrowed and slightly sinuate behind, margins explanate, especially at base, densely, minutely punctate, anterior angles depressed and blunt, posterior obtuse; the disc consisting of strongly convex areas, intersected by three wide transverse depressions, the first sinuous behind the apex, forming a depressed collar (giving the raised area behind it the effect of a bisinuate pseudo-margin), the second straight post-medial, the third following the outline of the base. *Scutellum* minute, round. *Elytra*: base widely bilobed, sides sinuate, arcuately enlarged behind shoulder, compressed before middle, narrowed behind to a pisciform apex (arcuately excised behind two external teeth); each with about three rounded costiform impressions becoming flatter towards apex, the intervals with large punctures, more or less seriate. Prosternum with middle area in the form of an elongate trapezium with its apex wider than the base, meso- and metasternum with sparse coarse punctures, abdomen sparsely punctate, the punctures smaller near apex, last segment truncate; under surface of tarsi forming a wide tomentose pad. *Dimensions*: 3½-4 x 1 mm.

Hab.—North Queensland: Cairns (Coll. Carter, Lea and Macleay Mus., also National Museum, Melbourne). Some carded specimens were given me some years ago as an *Agrilus* by the late Mr. Masters. Thinking it likely to be allied to Papuan forms, I carefully went through allied species in the British Museum collection and find that it is quite close (except in colour) to *A. mitratus* Chev., a Madagascar species. Its widely cleft head separates it from other known Australian Buprestidae. The following is another of a similar structure.

Type in Coll. Carter.

APHANISTICUS BROWNI, n.sp.

Differs from preceding as follows:—Shorter and wider; colour black nitid. *Head* more widely cleft (as seen from above, terminating behind in an oval, not a triangular excision), the eyes more prominent, antennae longer, the last four joints with short lamellae. *Prothorax* wider, the raised parts less convex, the medial transverse depression subobsolete (a mere scratch), the apex more sinuate, lateral foliation wider, sides more widely rounded, with greatest width at, or behind, the middle; anterior angles acute, posterior obtuse. *Scutellum* larger and triangular. *Elytra* wider and flatter, sides less sinuate, anterior half subparallel, thence obliquely narrowed, with feeble sinuation near apex; apices separated at suture, each subtruncate; striate-punctate, punctures foveate and shallow, intervals flat. The suture is sub-carinate near apex. Anterior and mid-tibiae curved, abdomen nitid and apparently impunctate. *Dimensions*: 2½-3 x 1 mm.

Hab.—Queensland: South Johnstone River (H. W. Brown). Mr. Brown has generously given me five of this interesting novelty, which he took in some quantity.

Type in Coll. Carter.

TENEBRIONIDAE.

Platydema sulcato-punctatum Cart.—Two examples, evidently the sexes, of this species are amongst some Tenebrionidae lately examined from Moa, Banks' Island, Torres Straits. I am thus able to add the following notes to my description and to make a correction (These Proceedings, 1922, p. 73): (1) The unique type is a ♀ (not ♂ as stated). The ♂ has two conical horns arising from the base of head, each of which is surmounted by two spinose bristles. In the ♀ the horns are replaced by longitudinal ridges which are punctured like the rest of the head;

(2) The ♂ example has some rufous markings, probably variable and inconstant near the base of the elytra, somewhat as in *P. rufibase* Cart., which is, however, quite differently sculptured. The ♀ example from Moa is identical with the type, and I have no doubt as to the two examples from Moa being conspecific.

Saragus marginellus Hope = *S. rudis* Macl. I have examined the Hope type, and at once recognized the Macleay species.

Amphianax sub-coriaceus Bates = *Agasthenes goudiei* Cart. = *A. euclensis* Cart. An examination of Bates' type makes the first synonymy certain, the second was recorded previously. This raises the question of the differentiation of the genera *Amphianax* and *Agasthenes*. An examination of the genotypes shows, to my mind, specific distinctions only, while some of the details of the author's descriptions are misleading. Thus, under *Amphianax*, he states "sides of submentum *not* dentiform" whereas I find, as stated in my description of *A. goudiei*, "tooth of submentum small and conical." The same is true of *A. frenchi* Cart. Again, of the tibiae of *Agasthenes*, the author says "the anterior with a single spur," whereas there are two, one being very small. Eliminating these distinctions, there is little to discriminate between the genera, which are, I consider, synonyms. The name *Agasthenes*, appearing two pages later is thus redundant. Thus *Amphianax* Bates = *Agasthenes* Bates.

Onosterrhus sculpturatus Blackb. and *O. veternosus* Blackb. An examination of the unique types of these species shows a very close likeness. Further material is necessary before establishing their relationship, but it is worth while to call the attention of other workers on the group to the possible identity of these two.

The genus *Brises* Pasc. is sufficiently distinct from the Tenebrioninae and the Cyphaleinae to warrant the establishment of a separate subfamily, Briseinae, for its inclusion, for the distinctive characters of which see my "Revision of the Tenebrioninae" (These Proc., 1914, pp. 45, 46).

Moerodes kershawi Cart.—This species is really out of place under *Prophanes*, where I suggested it should stand (These Proc., 1917, p. 718). Its punctate-striate elytra place it more suitably under *Platyphanes*.

Adelium.—The vast number and wide range of many species of this family is associated with a correspondingly wide variation. I now consider the following synonymy as established:—

(*a*) *A. pilosum* Pasc. = *A. scutellare* Pasc.

(*b*) *A. reductum* Pasc. = *A. aucilla* Pasc. = *A. convexiusculum* Macl. = *A. nitidum* Cart.

(*c*) *A. similatum* Germ. = *A. obesum* Pasc. (var.); while the identity of *A. aerarium* Pasc. with *A. augurale* Pasc. is open to suspicion. The type of the former, compared with that of the latter, shows brighter colour, and a sculpture on the middle area that may be described as a rectangular reticulation, rather than linear-costate.

(*a*) The range (from specimens before me) is Allyn River, Armidale, Dorrigo, Tenterfield, Narrabri, Brisbane.

(*b*) Has a similar wide range over Northern New South Wales, and an even wider range in Queensland.

(*c*) I have seen *A. obesum* only from Victoria.

Micretyche ferruginea Bates = *M. ryei* Bates (Types examined).

HETEROCHEIRA TROPICA, n.sp.

Ovate, nitid black or brownish above, under side and appendages dark castaneous. *Head* densely, minutely punctate, antennae not extending beyond half

the length of prothorax, joints 8-10 transverse, 11 subspherical. *Prothorax*: apex subtruncate, base lightly bisinuate, widest at base, thence arcuately narrowed to apex, front angles obtuse, hind rectangular, disc very minutely punctate, the punctures finer than on head. *Scutellum* large, equilatero-triangular. *Elytra* rather wider than prothorax at base, slightly obovate, with greatest convexity and width behind middle; striate-punctate, with small punctures half hidden in deep striae, intervals wide, nearly flat on basal half, clearly convex behind and sublaevigate (the minutest punctures discernible under a Zeiss binocular); prosternum nearly smooth on medial area, elsewhere, as also the meso- and metasternum, finely punctate, abdomen densely punctate. Tibiae spinose on exterior margins, apices enlarged. Those of the fore tibiae very wide, especially in the ♂. *Dimensions*: 5-6 x 2½ mm.

Hab.—North Queensland: Townsville, sea-beach (G. F. Hill and H. J. Carter). A species I have long had under notice, and which has been compared with possible allies in the British Museum Collection by Mr. K. G. Blair. I took a long series under sea-weed in July, 1921, and have also received it from Mr. G. F. Hill (late of the Institute of Tropical Medicine). Compared with *H. australis* Boisd. (the only other member of the genus), it is wider and more convex, with shorter antennae and legs, the tibiae, especially the fore-tibiae, more enlarged at apex; the upper surface is considerably more finely punctured, the elytral striae are deeper, the intervals less flat.

Type in Coll. Carter.

Note.—In January, 1914, Mr. T. G. Sloane and myself took *H. australis* Boisd. in similar quantity at Cottesloe Beach, near Fremantle, W.A., also under sea-weed. I have a specimen labelled by Blackburn, besides others from Bendin Is., N.W.A. (taken by Commander J. J. Walker) at roots of sea-grass and noted as *varieties* by Champion (Trans. Ent. Soc. Lond., 1894, p. 366). For detailed diagnosis of this species see Bates (*l.c.*, 1872, p. 266).

Diaclina (*Heterocheira*) *nitida* Cart. is a flatter insect with a differently shaped head, the base of pronotum more strongly bisinuate, hind tibiae curved, elytra and pronotum highly polished (See also These Proc., 1921, p. 307).

SARAGUS PUNCTATUS, n.sp.

Ovate, moderately convex, subnitid, black, margins of pronotum, elytra, as well as of abdominal segments, reddish, antennae and tarsi red. *Head* scarcely, or microscopically punctate, epistoma truncate in front, oblique and revolute at sides, its surface with four raised lines radiating from the forehead, two near middle short and sub-pustulose, the other two obliquely directed outwards from inner margin of eyes, the latter separated by a space of the width of one eye. *Prothorax*: apex arcuate-emarginate, base bisinuate, sides arcuately narrowed to front, rather abruptly and roundly narrowed behind, anterior angles wide and rounded, posterior subfalcate but not overlapping elytra, explanate margins wide and concave, with smooth surface; disc very finely and not densely punctate, nearly smooth at base, middle line indicated by smooth space near base and a short linear impression at apex. *Scutellum* equilatero-triangular. *Elytra* of same width as prothorax at base, thence ovately widened and bluntly rounded at apex, explanate margins smooth, wide on front half, thence narrowed, but moderately wide to apex; disc covered with rows of large, round punctures, the intervals near suture very irregular and sub-costate, the lines of punctures in this region also irregular, alternate intervals more or less raised, a little crenulate in parts, some-

times with an irregular transverse connection. *Prosternum* carinate, and pustulose, mesosternum with sparse fine pustules near sides, abdomen minutely punctate. *Dimensions*: 11 x 7 mm.

Hab.—New South Wales: Shoalhaven River (Taylor Coll. in Australian Museum). The specimen examined is nearest to, but very distinct from, *S. rugosipennis* Macl. (from the region south-west of Shoalhaven), differing from that species chiefly as follows: (1) Form rather shorter and wider, (2) Surface more nitid, (3) Explanate margins nowhere with any sign of corrugation, (4) Pronotal punctures very fine and rather distant (close and much coarser in *rugosipennis*), (5) Elytral punctures much more and transverse rugosity much less defined than in Macleay's species. Type (No. K. 44721) in Australian Museum.

NYCTOZOILUS CRASSUS, n.sp.

Widely ovate, convex body and appendages subnitid black, tarsi and apices of tibiae clothed with red tomentum. *Head* finely and densely punctate, antennae stout, apical half opaque and hirsute, joint 3 as long as 4-5 conjointly, 4-7 obconic, 8-10 nearly round, 11 ovate, 1½ times as long as 10. *Prothorax* arcuate-emarginate at apex, anterior angles prominent, bluntly sub-acute, base nearly straight for the greater part, a little sinuate before the backwardly-produced dentate hind angles, these overlapping elytra, widest a little behind middle, sides thence subangulately narrowed, arcuately in front, lightly sinuate behind, raised lateral border strongly thickened and round, widely concave within, this gutter smooth; disc closely finely punctate with a faint indication of a smooth medial line and a large foveate depression on each side of this. *Scutellum* transversely triangular, punctured like pronotum. *Elytra* as wide as prothorax at base and less than three times as long, widening rapidly from shoulders to half way; each with four wide and slightly flexuous costae, the inner three nitid, the fourth, near margin, opaque and less raised than the rest; the first and second costae adjacent but scarcely meeting at base, 3rd and 4th meeting at shoulders; transverse ridges irregularly branching from the costae, the interstices thus being irregularly ridged and foveate-punctate, though without defined reticulation, the sculpture becoming vague and sub-obsolete on the steep apical declivity, the sutural ridge less raised than costae; the usual lateral row of large punctures evident on basal half; under side finely, not very closely, punctate. Tibiae straight. *Dimensions*: 16 x 9 mm.

Hab.—New South Wales: Uralla (Dr. E. W. Ferguson). A single male example shows a distinct species which, by the combination of punctate, thickly margined pronotum and 8-costate elytra, is nearest to *N. marginatus* Cart., from which it differs in smaller size, shorter and proportionally wider form, the sides of pronotum sinuate behind, the lateral gutter not rugose, *inter alia*.

Type in Coll. Carter.

NYCTOZOILUS PUSILLUS, n.sp.

Oblong ovate, opaque brownish-black, apical joints of antennae piceous, of palpi red; tarsi and apices of tibiae clothed with golden tomentum. *Head*: epistoma concave in front, labrum very prominent and ciliate, whole surface (including prominent canthus) densely rugose-punctate, antennae moderately enlarging outwards, joint 3 as long as 4-5 conjointly, 4-8 oval, 9-10 short and transverse, 11 ovoid. *Prothorax*: apex arcuate-emarginate, base nearly straight, a little sinuate near angles, widest behind middle, sides thence roundly narrowed to the acute front angles, sinuately narrowed behind to meet the lightly produced, but

scarcely dentate hind angles, these overlapping elytra; a thin raised lateral border, lightly concave within; disc very densely punctate, the punctures smaller than on head, without rugosity; a smooth medial line shown near middle and a shallow depression on each side of this. *Scutellum* transversely triangular, punctured like pronotum. *Elytra* oblong, obovate, with four thin, nitid, sub-undulate costae, besides the wider but less raised sutural convexity, the interstices showing shallow irregularities of surface; the whole densely punctate, the punctures showing distinctly along the narrow costae; costae one and two meet on apical declivity but not at base, the third and fourth meet at both extremities of their length; a posterior loop on the declivity, connecting the junctions of 1-2 and 3-4. The lateral margin without any sign of the usual row of large punctures. Prosternum rugose-punctate, the rest of under side densely punctate (more coarsely so than the upper surface) the abdomen also longitudinally strigose. *Dimensions*: 12 x 6 mm.

Hab.—Queensland: Rockhampton. A single example, probably male, has long been, in my collection, wrongly determined as *N. daemeli* Haag. and figured in outline under this name (These Proc., 1917, p. 706), when I described *N. parvus* from Townsville. Last year, however, it was compared with a specimen of *daemeli* in the British Museum, and found to be distinct by its narrower oblong form, the less acutely produced hind angles of prothorax, and differently sculptured elytra. (In *daemeli* Haag., there are obvious transverse rugosities while the interstices are as described "vix punctatis"). It is thus possible that *N. parvus* Cart. is identical with *N. daemeli*. The unique type of *parvus* is in the National Museum, Melbourne. My outline figure of *parvus* is not unlike that of *daemeli*, as given by its author.

Type in Coll. Carter.

MENEPHILUS PULCHER, n.sp.

Elongate, parallel, upper surface brilliant peacock blue-green, elytra with three lateral intervals on apical half gold; antennae, legs and underside red. *Head* strongly and closely punctate, epistomal suture arcuate, antennal joints 1-4 unusually fine, three terminal joints strongly enlarged, joint 8 intermediate in size between 7 and 9. *Prothorax*: apex and base subtruncate, the latter feebly produced in middle, sides nearly straight, wider in front than behind, narrowly margined at base and sides, anterior angles widely rounded, posterior sharply defined but obtuse, disc clearly and rather closely punctate, middle line indicated near base by less punctate area. *Elytra* wider than prothorax at base, shoulders rounded, sides parallel; striate-punctate, striae deep, the punctures therein slightly crenulating the sides of the convex intervals, the latter finely punctate and sharply carinate at apex. *Sternum* nearly smooth, abdomen wanting. *Dimensions*: 10 x 4 mm.

Hab.—North Queensland: Deeral ♀ (Dr. J. F. Illingworth). An example generously sent me by its captor, and a second shown me in London by Dr. G. A. K. Marshall, who had also received it from Dr. Illingworth, can only be confused with *M. laetus* Cart. and *M. corvinus* Erichs. by colour and size. Smaller than either, it is easily distinguished by (1) the golden sides of elytra, accentuated (in the type) by the purple-blue horizontal margin, (2) straighter sides of prothorax, (3) the more strongly punctured surface, (4) more convex elytral intervals, and (5) especially by the different antennae, which in *laetus* and *corvinus* are more gradually enlarged externally. The abdomen is, unfortunately, wanting, but the type is otherwise in good condition.

Type in Coll. Carter.

NOTOPRATAEUS (gen. nov. Heterotarsinorum).

Ovate, winged; eyes large, transverse, coarsely granulated; antennae long (about extending to base of prothorax when at rest), joints enlarging outwards, the last three considerably larger than the rest; maxillary palpi long, apical joint securiform, mentum and labial palpi small, mandibles simple, epistoma scarcely separated from front by suture; prothorax not concealing eyes, wider than head, base and apex of nearly equal width, both bisinuate; sides not explanate, with narrow entire border. Elytra coarsely irregularly punctate; epipleurae narrow; prosternal process received into a deep triangular notch of the mesosternum; procoxae globose, middle coxae with trochantins, postcoxae rather widely separated by a triangular intercoxal plate; apices of tibiae not enlarged and each bearing two short spines; tarsi with silky-pubescence beneath, penultimate joint bilobed, claws small; posterior tarsi with first and fourth joints of equal length, each as long as the second and third conjointly, the latter two of equal length.

This is the first record of a genus of the tribe *Heterotarsini* in the Australian fauna. According to Mr. K. G. Blair, it is near *Paratenetes*, but following Leconte and Horn (Col. N. Amer.) it would appear to be still nearer the American genus *Prataeus*.

NOTOPRATAEUS LITORALIS, n.sp.

Narrowly oval and rather flat; nitid black, sparsely clothed at sides, more densely beneath, with pale, short bristles; antennae, palpi and tarsi red. *Head*: epistoma widely rounded, slightly produced in the middle; mandibles and labrum prominent; coarsely, not closely punctate; antennae with joints 1-2 short and stout, 3 half as long again as 4, 4-6 longitudinally ovate, 7-8 pear-shaped, as wide as long, 9-10 transversely oval, 11th largest, sub-globular. *Prothorax* transverse quadrangular, apex more sinuate than base, front angles widely rounded, sides rounded, widest at middle, lightly sinuate on basal half, posterior angles sharply rectangular, disc coarsely punctate without sign of medial line, basal or other foveae. *Scutellum* triangular, smooth. *Elytra* distinctly wider than prothorax at base and 2½ times as long, humeral angle obtuse, showing a narrow epipleural fold, a narrow border evident from above for two-thirds of length; coarsely, irregularly punctate, each puncture, where not abraded, bearing a short hair; under side more densely setose-punctate. *Dimensions*: 4 x 1.6 mm.

Hab.—N. Queensland: Townsville (H. J. Carter). I took a single example of this interesting species in company with *Heterocheira tropica* on the beach.

EUTOREUMA MINOR, n.sp.

Elongate, convex, nitid coppery-bronze above, reddish-brown beneath, antennae, tibiae and tarsi red. *Head* densely punctate, forehead canaliculate, eyes large, half-concealed by prothorax, separated by a distance about equal to the diameter of one eye; antennae slender, about reaching base of prothorax, apical joints lightly enlarged. *Prothorax* arcuate-emarginate at apex, anterior angles acute and prominent (extending in front of eyes); base strongly bisinuate, posterior angles acute, sides lightly arcuately widened from apex hindwards, the arcuation strongest near front; a thin raised lateral border, narrowly sub-concave within; a medial and two larger foveae near base; disc closely and rather strongly punctate. *Scutellum* triangular with rounded sides, punctate. *Elytra* of same width as prothorax at base, sides subparallel for the greater part; apical half more tumid and convex than basal half; disc irregularly vermiculate-punctate,

with bladder-like swellings irregularly disposed, interspersed with foveate punctures; of these, some longitudinally arranged near suture on apical third; whole surface also with a close minute system of punctures; prosternum finely punctate, abdomen longitudinally strigose. *Dimensions*: 7 (plus) x 3 mm.

Hab.—S. Queensland: Coomera (Mr. R. Illidge). A specimen was generously given me by its captor some years ago and then diagnosed as a *Mithippia*. It is, however, in structure, sculpture and colour extremely like its only congener, *E. cupreum* Cart., from which it differs as follows:—Size much smaller, pronotum more closely and coarsely punctate, with the lateral border much finer, the anterior sides more arcuate. The elytra also show a more distinct system of ground punctures.

Type in Coll. Carter.

CHARIOTHES DODDI, n.sp.

Rather widely ovate, moderately convex, head, pronotum, underside and legs nitid black, elytra bright violet, antennae, palpi and tarsi red, the last clothed beneath with long yellow hair; the penultimate joint with a tassel of the same. *Head* finely, closely punctate, epistoma with rounded depression on each side, antennae with joint 3 longer than 4, joints 7-11 transverse, 11 largest, ovoid. *Prothorax* transversely convex, apex feebly sinuate, the middle very little prominent, anterior angles widely obtuse and depressed, base lightly bisinuate, posterior angles sub-rectangular; sides rather widely rounded, widest in front of middle and without sinuation, lateral border narrow, disc finely, sparsely punctate. *Scutellum* small, triangular. *Elytra* ovate, slightly wider than prothorax at base, striate-punctate, the striae well-marked and deeply furrowed at apex, the punctures small, half-concealed in striae on basal half, obsolete at apex, intervals convex throughout, strongly so behind, also impunctate, the suture carinate on apical third. Gular area transversely rugose, prosternum coarsely punctate, its apical process with deep longitudinal sulcus; abdomen strongly punctate except on two apical segments, here sub-obsolete, all tibiae bowed.

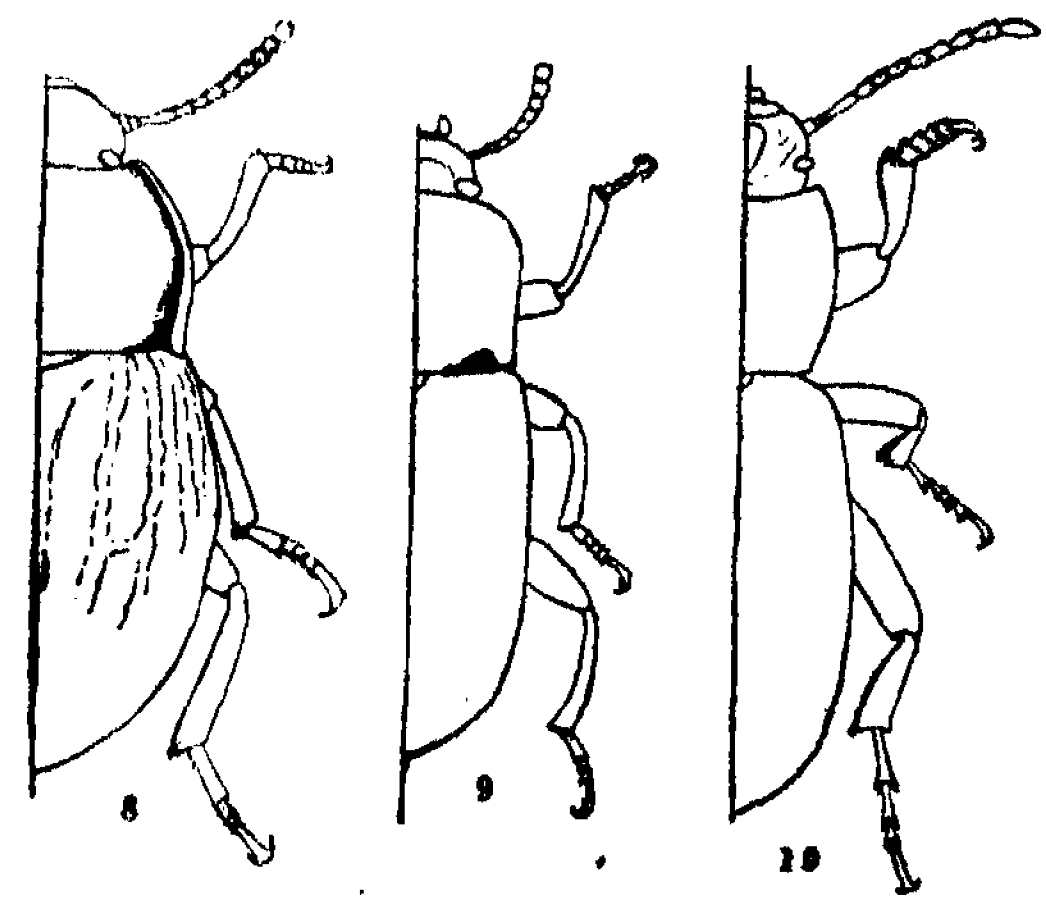
Hab.—N. Queensland: Cairns district (Mr. F. P. Dodd). Another of Mr. Dodd's captures in this region of unlimited entomological supply. It is nearest *C. subviolacea* Cart. in size and colour and differs from it as follows:—General surface, especially elytra, more depressed and more widely oval, the pronotum more convex, elytra striate-punctate; the colour of elytra much brighter. It is of quite different form from the sub-cylindric *striato-punctata*, Macl., with more even striation and smaller punctures. It is not very near any of the 30 species recently described by Gebien under the preoccupied name *Chariotheca* (see These Proc., 1914, p. 78) from Papua.

Type in Coll. Carter.

APTEROTHECA PUNCTIPENNIS, n.sp. (Text-fig. 9.)

Robust, ovate; head, pronotum, underside and legs nitid black; antennae and tarsi reddish, elytra violaceous with cyaneous tints near base and suture. *Head*: epistoma impunctate, forehead finely, sparsely punctate; antennae gradually widening outwards, joint 1 concealed by canthus, 7-11 increasingly transverse, 11 longer than 10. *Prothorax* transverse and convex, apex and base subtruncate, front angles depressed and widely rounded off; hind angles acute, emphasized by the meeting of the basal and lateral margins; widest at middle, sides well rounded, subsinuate behind; a narrow, raised lateral border; a transverse depression within basal margin; disc microscopically punctate. *Scutellum* arcuate-triangular.

Elytra of same width as prothorax at base, convex and oval; striate-punctate, with 8 rows of large punctures connected by shallow striae, besides a short scutellary row of about 3 punctures; seriate punctures not very close, 4 punctures (two in adjacent rows) forming a square, intervals flat and impunctate. Gular region transversely striolate, sternum and abdomen finely punctate, the metasternum and first segment of abdomen with fine longitudinal striolations. All tibiae a little curved, hind tibiae of male strongly so. *Dimensions*: 14 x 6 mm.



Figs. 8-10.
8. *Nyctozoilus crassus*. 9. *Apterotheca punctipennis*, ♂.
10. *Nototrintus hackeri*, ♂.

Hab.—South Queensland, National Park (Mr. H. Hacker). Two examples (♂, ♀) form another of Mr. Hacker's discoveries in this prolific region. This is the third known species of a genus lately separated from *Chariotheca* by Gebien (Résultats de l'expedition scientifique Néerlandaise à la Nouvelle Guinée, 1920, p. 348), under its present title. It is readily distinguished by colour and elytral sculpture from *A. amaroides* Pasc. and *A. besti* Blackb. Vide infra), the punctures in the elytral series being as large as in *Encyalesthus punctipennis* Pasc.

Types in Queensland Museum.

The three species may be thus separated:—

A. Pronotum, legs and underside black.
 1. Elytra iridescent (purple-cyaneous); very finely striate-punctate. .. .. *amaroides* Pasc.
 2. Elytra deep violet (less nitid than 1), strongly striate-punctate. .. .. *punctipennis*, n.sp.

AA. Pronotum, legs and underside blue.
 Elytra fiery coppery. .. .. *besti* Blackb.

(Blackburn deduced from Pascoe's omission that the elytra of *amaroides* were not striate. I have a cotype, however, from Lizard Is., given in exchange at the British Museum, which shows a fine striation, containing small punctures).

I have already noted (Proc. Linn. Soc. N.S.W., 1911, p. 215) the differentiation of the two groups of *Otrintus*. I now propose the generic name *Noto-*

trintus for the reception of *O. jacksoni* Cart., *O. striatus* Cart. and *O. acaciensis* Cart., of which the first is the genotype.

NOTOTRINTUS (gen. nov. Adeliinarum).

Near *Otrintus,* but separated from it by the flatter, non-cylindric form, prothorax trapezoidal or sub-cordate; widest near apex, base truncate or lightly arcuate, hind tarsi long. Elytra sulcate. In *Apasis*—another allied genus—the apex of pronotum is not emarginate, the front angles depressed and rounded, while in *Nototrintus* they are more or less explanate and emarginate, and quite sharply emarginate in *Otrintus*. The following adds another species to the group.

NOTOTRINTUS HACKERI, n.sp. (Text-fig. 10.)

Oblong ovate, subnitid black; antennae and tarsi piceous, the latter clothed beneath with red tomentum. *Head* strongly, not closely punctate, eyes rather narrowly transverse, antennae extending to base of prothorax in the male (not quite so far in the female); joint 3 half as long again as 4; 4-10 oval, very slightly progressively enlarged, 11 longer than 10, ovate acuminate. *Prothorax*: apex arcuate, anterior angles sub-rectangular with the extreme apex blunt, base truncate, posterior angles defined and obtuse; sides arcuately converging from near apex, subsinuous near hind angles; all angles a little explanate, the explanation extending narrowly along sides, extreme border narrowly raised throughout; a fine medial line clearly cut, whole disc closely and finely punctate. *Scutellum* rather widely triangular. *Elytra* oblong ovate, shoulders widely rounded, epipleural fold well raised in this region; sulcate, with 10 rather deep sulci, including the extreme lateral one, intervals carinate towards base and apex, and becoming sharper laterally, everywhere convex. Underside smooth and nitid, hind tarsi having first and fourth joints subequal in length. *Dimensions*: 16-17 x 5.5 mm.

Hab.—Queensland: National Park (Mr. H. Hacker). Five examples sent by Mr. Hacker show the largest and most nitid of the four species. The single male differs from the female in having greatly enlarged front tarsi, widened tibiae, the hind tibiae rather strongly curved and in having longer antennae. I am pleased to name this insect after the enthusiastic and capable entomologist who is doing such admirable work at the Queensland Museum.

Types in the Queensland Museum.

The following table will distinguish the four known members of the genus.

Nototrintus.

1-3. Colour opaque brown-black.
2. Pronotum subcordate, elytral intervals sharp, 12-14 mm. long. *striatus* Cart.
3. Pronotum narrower, elytral intervals rounded, 16-17 mm. long. *jacksoni* Cart.
4-6. Surface nitid.
5. Colour brown-black, elytral intervals clearly punctate, 13-15 mm. long. .. .. *acaciensis* Cart.
6. Colour black, elytral intervals impunctate, 16-17 mm. long. *hackeri*, n.sp.

N.B.—All four species are denizens of the dense brush of the regions limited by the Bellinger River and the Queensland National Park, MacPherson Ranges.

LICINOMA PUNCTICEPS, n.sp.

Subcylindric, nitid black, labrum, palpi, antennae and tarsi red, apical joints of antennae pale red. *Head* with epistoma unusually elongate, its sides obliquely narrowed to front, the whole forehead and epistoma very coarsely punctate, antennae with joint 3 a little elongate, 4-10 moniliform and slightly enlarging outwards, 11 much larger and pear-shaped. *Prothorax*: apex and base subtruncate, anterior angles feebly emarginate and obtuse; widest before middle, sides lightly rounded and narrowly margined, disc strongly and unevenly punctate, the punctures smaller than on head and becoming finer near middle, a foveate impression towards each side; without sign of middle line. *Scutellum* small. *Elytra* slightly wider than prothorax at base; striate punctate, the striae wide and deep, almost concealing the punctures; intervals flat, very minutely punctate but not setose, the 1st, 3rd, 5th, and 7th wider than the rest. *Prosternum* and sides of *mesosternum* coarsely, metasternum and abdomen finely (the apical segment densely) punctate. *Dimensions*: 11 x 4 mm.

Hab.—New South Wales: Bowral. A single specimen probably taken by the late Mr. Helms, is clearly differentiated from its nearest ally *monticola* Blackb. by its elongate head and the unusually coarsely punctate head and pronotum in combination with flat, non-setose elytral intervals of unequal width.

Type in Coll. Carter.

LICINOMA UMBILICATA, n.sp.

Oblong oval, pale bronze, subnitid, underside, legs and apical half of antennae red, basal half of antennae, tarsi and upper part of tibiae testaceous. *Head* finely punctate, epistomal suture arcuate, antennae with basal joints linear-ovate, 6-11 gradually enlarged, 11 not much larger than 10. *Prothorax* arcuate-emarginate at apex, base sub-truncate, sides rather widely and evenly rounded; anterior angles a little rounded and subacute; posterior obtuse; disc with fine, close, shallow punctures, two foveate depressions near middle, one on each side of middle line, the latter lightly impressed at apex, widening into a pear-shaped fovea at middle, thence obsolete. *Scutellum* triangular. *Elytra* ovate, widest about middle, shoulders obsolete; striate-punctate, the striae well-marked, the seriate punctures small and close, intervals quite flat, the 3rd, 5th, 7th and 9th with umbilicate nodules; in general * each bearing a coarse spinose oblique bristle; the 3rd having about five, the 5th about seven, the 7th about eleven, more or less evenly spaced, those on the 9th appearing in outline at the sides. Underside finely punctate: hind tarsi with basal joint about as long as the rest combined. *Dimensions*: 8 x 3 (+) mm.

Hab.—Dorrigo (Mr. S. W. Jackson). A puzzling species that on a strict interpretation of Pascoe's phrase "*prothorax* apice haud emarginato" would require separation from *Licinoma*. It, however, accords with the genus in other respects, while the extent of "emargination" depends somewhat on the point of view. The "arcuation" is slightly deeper than that of *L. aerea* mihi as shown in figure (These Proc., 1920, p. 242, fig. 8). The sculpture of the elytra can only be compared with that of the Tasmanian *L. nodulosa* Champ.; but in this species is feeble, chiefly confined to the apical region, and unaccompanied by setae.

Type in Coll. Carter.

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* The unusually coarse spinose bristles are apparently easily abraded, since they are irregularly absent from some of the nodules.

CHALCOPTERUS LUCIDUS, n.sp.

Robust, oval, convex; head, pronotum, underside and legs nitid black, antennae and tarsal clothing black; elytra burnished, pale greenish-copper, very brilliant. Head: eyes separated by space nearly equal to the diameter of one eye; antennae robust, little enlarged externally, 3rd joint proportionally longer than in *affinis* Bless. *Prothorax*: apex lightly arcuate, base sub-truncate, front angles depressed and very wide, posterior acute, sides gently arcuately narrowing from base to apex; disc very finely sparsely punctate, medial line smooth. *Scutellum* black, nitid, equilatero-triangular. *Elytra* strongly widened at shoulders, thence sub-parallel to apical third; minutely striate-punctate, the fine shallow striae only seen by close scrutiny, the seriate punctures much smaller than in *affinis* Bless. or *sparsus* Blackb.; intervals flat and impunctate; metasternum and abdomen finely strigose. *Dimensions*: 14.5-15 x 8-8.5 mm.

Hab.—Western Australia: Beverley (Mr. Tepper, Junr.), and N. Territory. A robust species after the manner of *affinis* Bless. and *sparsus* Blackb.; nearer the latter, but distinguished by the larger form, the extreme brilliance of its surface and the absence of any sign of interstitial punctures on the elytra. I have had the species long under observation, but, not having clearly identified *sparsus* until my recent visit to the British Museum, had left it undescribed till now. The colour of elytra is elusive and apparently uniform, or nearly so, but the metallic reflections are decidedly greenish, and there is an entire absence of purple. Two examples, including the type in Coll. Carter, one in the British Museum, others in the South Australian Museum.

CHALCOPTERUS PRAETERMISSUS, n.sp.

Elliptic, convex; head, underside and appendages black, pronotum and elytra green, with metallic purple sheen near hind angles of pronotum, also on humeral callus and sides of elytra. Tarsal clothing yellow. *Head* closely and rather strongly punctate, eyes bordered by sulcus, separated by about the length of 2nd joint of antennae; antennae enlarged towards apex, joints 4-11 subequal in length. *Prothorax*: apex arcuate, base bisinuate, sides well rounded and converging to apex, all angles obtuse; disc irregularly and rather coarsely punctate, the medial line and a few small irregular areas more or less laevigate. *Elytra* regularly elliptic, considerably wider than prothorax, humeral callus prominent; seriate-punctate, punctures in striae near middle very much as in *C. smaragdulus* F. but much less diminishing in size towards apex than in that species; intervals flat and strongly punctate (as in *C. variabilis* Bless.). Underside striolate. *Dimensions*: 13 x 7 mm.

Hab.—N. Queensland (Kuranda). A species long overlooked in my collection, superficially like green examples of *smaragdulus* F., but an examination at once shows the following distinctions: Form more regularly elliptic (in *smaragdulus* the elytra are ovate with the big end at base); eyes less close, ocular sulcus present, punctures of pronotum and elytral intervals much stronger, seriate punctures well-marked to extreme apex; tarsal clothing yellow. The species should be placed in my table (Trans. Roy. Soc. S. Aust., 1913, p. 31) after *rusticus* Blackb. (= *cupreus* F.) from which it differs in smaller size and its strong interstitial punctures.

Type in Coll. Carter.

STRONGYLIUM VERTEBRALE, n.sp.

Elongate, subcylindric, glabrous; head, pronotum, scutellum, the greater part of elytra and underside metallic peacock-blue (in one example head and pronotum dark metallic green); elytra with suture, base and margins red, this colour varying in extent, but generally covering one elytral interval at suture and sides and widening towards base and apex. Underside of head, coxal regions, epipleurae and margins of abdominal segments more or less red or suffused with red, antennae and legs blue-black, tarsal claws yellow. *Head*: labrum prominent, forehead coarsely, epistoma more densely and finely punctate, eyes moderately prominent, widely separated, in ♂ by the width of an eye, in ♀ more widely separated. Antennae extending beyond base of prothorax when at rest, joints 1-2 short and stout, 3-5 sub-linear, 3 shorter than 4-5 conjoined, 6-10 subconic, of equal length but widening outwards, 11 oval, as long as 10. *Prothorax* transverse and sub-depressed, apex and base sub-truncate, all angles rounded off, the anterior widely so, sides variably widened, in ♂ examples nearly straight or feebly subangulately widened near middle, in ♀ more widely rounded, a raised border throughout, showing more prominently at apex and middle of base, medial line sometimes indicated by short depression near middle and absence of the coarse, irregular puncturation elsewhere displayed on disc. *Scutellum* arcuate-triangular, the apex rounded off, impunctate. *Elytra* considerably wider than prothorax at base, slightly widened behind middle, shoulders rather squarely rounded, strongly striate-punctate, with nine deeply cut striae, besides a shorter scutellary stria, containing rather large, irregularly-spaced punctures; intervals convex and impunctate, underside almost smooth, the abdomen with light shallow punctures, the episterna with a few larger punctures. *Dimensions*: 8-9½ x 2½-3½ mm.

Hab.—North Queensland (Cooktown, Kuranda, Mackay, etc.). A common species found in most collections (11 examples now before me) that I have hitherto considered as *Pseudo-strongylium viridipenne* Kraatz. The latter species, however (described from a single example) possesses the following characters inconsistent with this determination: "apex of antennae reddish," "joints small and threadlike," "eyes almost adjacent," "tibiae at base and thighs red" (translated from German). Some examples are almost entirely cyaneous, this colour varying from green-blue on head and pronotum to bright violaceous on elytra, in old specimens becoming dingy, while the amount of red is variable. The appendages, except tarsal claws and scutellum, are in all cases dark.

Type in Coll. Carter.

EBENOLUS BANKSI, n.sp.

Oblong, subcylindric; head, pronotum, underside and legs nitid black, elytra green and purple (the former colour predominating on the middle area), antennae piceous, tarsi red. *Head* minutely punctate, strigose on basal ridge, eyes almost contiguous, the interspace in apical half of ♂ narrowly lineate, thence triangulately widening behind; in ♀ the interspace is twice as wide in front and much more rapidly widened behind; in both sexes the widened interspace impressed; antennae long and slender, joints 3-11 successively shorter and slightly wider. *Prothorax* subquadrate, wider than long and rather wider in front than behind; apex, base and sides nearly straight, narrowly margined throughout, anterior angles rounded, posterior rectangular; disc with fine, shallow punctures, with an area of larger punctures near middle of base, medial channel lightly impressed (more strongly so in ♀) on basal half. *Scutellum* equilatero-triangular,

punctate. *Elytra* considerably wider than prothorax at base, shoulders angulate, sides sub-parallel; seriate-punctate, the first two rows of punctures in sub-striate depressions, intervals impunctate and slightly convex, the two first more strongly so; the punctures round, moderately large and regular. Prosternum sulcate, abdomen finely punctate, post-tarsi with 1st joint shorter than the rest combined. *Dimensions*: ♂. 12-13 x 4-4½ mm.; ♀. 13 x 5 mm.

Hab.—Moa, Banks Island, Torres Straits (Mr. W. McLennan). Two ♂ and one ♀ in the Australian Museum, presented by Mr. H. L. White, show an evident ally of *E. vernicatus* Fairm. and *E. sub-viridis* Geb., both from New Guinea. Besides differing in colour from both, the former is said to be sulcate between the eyes, the pronotum "multi-impresso," and elytral punctures "apice obsoleto"; from the latter it is separated by closer eyes and elytral punctures not at all in pairs. *E. wollastoni* Blair is larger *inter alia*. I have named it after the great naturalist whose name is associated with its habitat.

Type in Australian Museum.

Ebenolus minor, n.sp.

Oblong, subcylindric; head, pronotum, underside and legs black, the two first subnitid, the two last nitid; elytra blue, sometimes tending to purple with purple and golden metallic gleams near apical declivity; antennae, palpi and tarsi red. *Head* impressed on front, densely and finely punctate, intereye-space in ♂ about the length of 1st antennal joint, in ♀ rather more distant; antennae slender, extending beyond the base of prothorax, joints on basal half sublinear, widening and growing shorter outwards. *Prothorax*: apex and base truncate, sides nearly straight, slightly wider in front than behind; the anterior angles obtuse and a little blunted at tips, posterior angles sharply rectangular; disc densely and finely rugose-punctate, the narrow lateral margins not visible from above; transversely impressed near basal margin, medial line not indicated. *Scutellum* triangular, punctate. *Elytra* wider than prothorax at base, shoulders sub-angulate, but rounded; sides parallel; striate-punctate, the seriate punctures round, large, rather close and regular; intervals impunctate, generally flattish, some intervals towards sides and apex lightly convex. Sternal regions densely, the abdomen closely and finely punctate; post tarsi with first joint about as long as the rest combined. *Dimensions*: 7-7.5 x 2-2.5 mm.

Hab.—Moa, Banks Island, Torres Straits (W. McLennan, in Australian Museum, presented by Mr. H. L. White). Several examples recorded as attracted to light by Mr. McLennan; both sexes evidently present amongst the nine specimens closely examined, which show little variation of colour or size. Its small size separates it from any described species, while it is further distinguished from the species having a black prothorax and coloured elytra by its densely rugose-punctate pronotum.

Type in Australian Museum.

The genus *Ebenolus* Fairm., with genotype *E. vernicatus* Fairm., segregates a special group of the heterogeneous and numerous Strongyliinae that appears to have its zoo-centre in Papua. It probably includes some of our Australian species, especially *S. macleayi* Pasc., with which Mr. Blair compares his *S. wollastoni*, and which Gebien has recently placed under *Ebenolus*, while describing six new species from New Guinea. The chief characters appear to be: eyes close, antennae long and slender, prothorax subquadrate, its sides margined, prosternum sulcate, body oblong, non-gibbous, the shoulders angulate without tuberosity.

CISTELIDAE.

Homotrysis (*Allecula*) *flavicornis* Macl.—Since the Australian species of *Allecula* are now merged in *Homotrysis* the name *macleayi*, given by Borchmann in the Junk catalogue to this species, is superfluous. There is a black variety of this, commonly found round Sydney, as well as the typical brown form. Possibly the brown colour shows immaturity.

NEW TRILOBITES FROM BOWNING, WITH NOTES ON *ENCRINURUS* AND *CORDANIA GARDNERI*.

By JOHN MITCHELL, late Principal of the Technical College and School of Mines, Newcastle.

(Plate x.)

[Read 26th March, 1924.]

Introduction.

In 1907 the late General A. W. Vogdes, an eminent authority on trilobites, gave a complete history of the genus *Encrinurus* (Trans. San Diego Soc. Nat. Hist., i. (2), 1907, pp. 61-83), and proposed its division into the genera *Encrinurus* and *Cryptonymus*, claiming that the latter name should be retained for the generic name of the group. If the rule of priority is to be followed strictly, the claim for *Cryptonymus* appears unquestionable, but the fact that *Encrinurus* has been in common use for some eighty years should be taken into consideration.

The separation into *Encrinurus* and *Cryptonymus* depends on the presence or absence of spines on the genal angles: those forms with spines are placed in the genus *Encrinurus*, of which the generic type is *Encrinurus punctatus; Cryptonymus* is to include those forms having rounded genal angles, the generic type suggested being *E. variolaris* Brong. As far as the proposed genera and generic types are concerned, the present writer agrees with these divisions, but considers the features on which the separation of the genera is based are not of generic value; he admits that the separation may be useful in practice. If spines on the genal angles be accepted as features having generic or subgeneric values, then several old-established genera are open for similar generic division. Should Vogdes' proposed classification of *Encrinurus* be accepted, all the Australian species recorded up to the present time would have to be placed in *Cryptonymus*, for they all have rounded genal angles.

It has occurred to the writer that a division of the group might be effected on well marked and constant pygidial characteristics, viz:—the continuity or discontinuity of the rings of the axis of the pygidium. Under this classification, those species of *Encrinurus* having continuous axial rings on their pygidia would be placed in the genus *Cryptonymus*, and have *Cryptonymus* (*Encrinurus*) *variolaris* for the generic type. Such as have the axial rings of their pygidia discontinuous or medially interrupted, wholly or in part, would form the genus *Encrinurus*, the type species being *Encrinurus punctatus*.

Adopting this classification, the following Australian species would be included in *Cryptonymus*:—*E. etheridgei* E. and M., *E. duntroonensis* E. and M., together with *Cryptonymus platynotus, C. incertus, C. robustus, C. perannulatus*, and *C. angustus*, described in the present paper. In the genus *Encrinurus* would

be placed *E. mitchelli*, *E. silverdalensis*, *E. bowningensis*, *E. rothwellae*, and the species *E. frontalis* here described. The solitary *E.* (*C.*) *spryi* would find its resting place in *Cryptonymus*.

The writer is aware that to establish a genus on a feature of the pygidium of a trilobite is exceptional; but in the present case, the separation of the genera under discussion, on the lines stated by him above, seems sound and reasonable; and especially does it appear so, when the classification is applied to the Australian species. Also, seeing that the genus *Encrinurus* itself is established on a feature of the pygidium, it seems reasonable, if further division becomes necessary, to use some well-marked pygidial character, as is proposed above.

The general characters for *Encrinurus* would remain as they have been heretofore recognised. The genus *Cryptonymus* would have a head-shield and thorax of the types common to the Encrinuridae, and its separation from *Encrinurus* would depend on the interrupted or continuous rings of the axis of the pygidium.

In the following pages eight new species of trilobites from the Bowning (Bounyongian) beds of New South Wales are described and figured. Two of these (one doubtfully) are placed in the genus *Bronteus* (*Goldius*). Six new species are placed in the genera *Encrinurus* and *Cryptonymus*. Up to the present, no less than ten species of *Encrinurus* have been recorded from New South Wales, four (*E. punctatus* Brunn., *E. barrandei* De Kon., *E.* (*Cromus*) *bohemicus* and *E. murchisoni* De Kon.) by De Koninck (Foss. Pal. Nouv. Galles du Sud, Pt. I., 1876, pp. 49-55, Pl. i., figs. 8, 9, 9*a*-*b*.).

When dealing with the Silurian Encrinuridae of New South Wales, the late R. Etheridge, junior and the writer expressed certain opinions with reference to the correctness and value of these determinations of De Koninck (Proc. Linn. Soc. N.S.W., xl. (4), 1915, pp. 651-654); and the present writer is unaware of any reason why the opinions then expressed should be altered. By the addition of the species of *Encrinurus* and *Cryptonymus* (or *Encrinurus* alone) dealt with in the present paper, the species of these genera have been increased to a greater number than has been recorded from New South Wales for any other genus of trilobite; and still, to the writer's knowledge, there are fragments of new species of these genera awaiting description.

In Europe and North America, *Encrinurus*, *sens lat.*, is practically confined to the Ordovician and Upper Silurian systems. In New South Wales, species occur from the base to near the top of the Bounyongian beds and, up to the present, the whole of this formation has been considered to be of Upper Silurian age. Recent study, however, has led the writer to conclude that the uppermost beds, at least, are of Lower Devonian age; and in these beds *Encrinurus* is not known to occur. The Yarralumla beds are the equivalents of the Lower Trilobite beds of Bowning, as are also, in part or altogether, the Back Creek beds of the Tarlo River. The age of the Duntroon beds has not yet been satisfactorily solved, but, in the opinion of the writer, they are older than those of Bowning. It may, therefore, be taken as approximately correct that, in New South Wales, and indeed in Australia, *Encrinurus* (including *Cryptonymus*) is confined to the Upper Silurian and older formations.

Family ENCRINURIDAE.

CRYPTONYMUS PLATYNOTUS Mitchell. (Plate x., fig. 1.)

The specimen available has the anterior portion of the head-shield and a small part of the tip of the pygidium missing. The head-shield is subsemi-elliptic, its surface being densely tuberculate, with medium to small tubercles; the surface

of the glabella is removed, leaving the greater part of the hypostoma exposed; the neck-furrow is narrow and ill-defined, its lateral extensions wide and distinct; neck-ring and its lateral extensions similar to a thoracic segment; fixed cheeks large, the wings unusually wide postero-anteriorly, densely tuberculate, the tubercles being arranged in nearly regular rows; eyes placed well forward and outward. Thorax much wider than long (25:15 approx.), smooth; axis spindle-shaped, widest at the third and fourth rings, mildly convex, each ring subtuberculate at its bases; axial furrows deep; side lobes almost horizontal between their origin and their fulcra, thence steeply deflected; an indistinct tubercle at the fulcral point of each pleura; terminals of the pleurae strongly imbricate and curved forward. Pygidium triangular, moderately convex, about two-thirds as long as wide (13:20); axis mildly convex, rings continuous, about twenty-two in number (on the specimen there are nineteen, but a part of its end is broken off); medially there are five inconspicuous tubercles; the junction with the thoracic axis is quite gradual. Pleurae of the side lobes are 9 to 10, each, except the first, slopes gently from the origin to the margins and ends in ploughshare-like edges, having a fairly strong backward curve.

On a casual inspection this may easily be taken for *E. mitchelli;* but from that species it is separated by (1) the great size of its fixed cheeks and their alae, (2) the continuity of the axial rings of its pygidium, (3) the gradual merging of the thoracic axis into that of the pygidium, (4) the more forward position of the eyes, and (5) less convexity and prominence of the axis. From *E. bowningensis* and *E. silverdalensis* E. and M., it is easily distinguished. In the size of its fixed cheeks and forward position of the eyes it resembles *E. rothwellae;* but differs from that species, widely in other respects.

The outstanding features of the species are the large fixed cheeks, anterior and lateral position of the eyes, general low convexity, continuity of the axial rings of the pygidium, and the indistinctness of the medial tubercles of the pygidial axis.

Loc.—Bowning Creek, Lower Trilobite beds.

CRYPTONYMUS INCERTUS, n.sp. (Plate x., fig. 2.)

Of this species only the pygidium, with two complete thoracic segments attached, is known. The description of the pygidium is as follows: Triangular, about two-thirds as long as wide, fairly well inflated, smooth or nearly so. Axis prominent, convex, made up of numerous rings (more than twenty), ending bluntly short of the posterior margin, subtended by a pair of pleural segments, its greatest spread approximately equals one-fourth of the greatest width of the pygidium (5:19); its junction with the thorax is quite gradual, along the medial line there are faint traces of two tubercles. Side lobes consist of twelve pairs of pleurae, convex, only the posterior three pairs strongly directed backwards, geniculation indistinct. *Dimensions*: Length 13 mm., width 19; greatest height of axis 5; greatest height of side lobes 4 mm.

The present pygidium resembles, in general contour and pleural characters, *E. bowningensis* more than it does any other Australian species; but from the pygidium of this species it differs in having twelve pairs of pleurae instead of nine, the axis ending short of the margin, and in its rings being continuous. These differences alone are sufficient to separate the two specifically. The pygidium of *C. robustus* mihi and the one under discussion agree in several features, but the former is densely, finely and evenly granulated, while the latter appears

to be practically smooth; the pleurae of the former are less in number and less prominent than those of the latter. The pygidium of the latter does not possess the distinct border which is present in the former.

Loc. and horizon.—Railway cutting near the Bowning railway station. Upper Trilobite Beds, Bounyongian Series.

CRYPTONYMUS ROBUSTUS, n.sp. (Plate x., fig. 3.)

Complete form oval. Head-shield almost semicircular, densely tuberculate. Glabella pyriform, mildly convex, greatest width equal to length, tubercles relatively large and fairly even in size, not prominent, those adjacent to the anterior margin arranged subconcentrically, the posterior ones forming one or two transverse rows, the remainder irregularly placed. There are five pairs of glabellar furrows and, if such they may be called, the lobes are conspicuous, subquadrate in shape and depressed, the posterior pair being inconspicuous; axial furrows deeply incised. The lobe-like tubercles of the fixed cheeks, corresponding to and opposite those of the glabella, are prominent; neck-furrow inconspicuous, its lateral extensions across the fixed cheeks narrow and deep, neck-ring narrow, fairly prominent and granulated, its lateral extensions also narrow. Fixed cheeks well developed, wide between the facial sutures and the posterior furrows, its granulation like that of the glabella, moderately inflated, lower than the glabella. Free cheeks large, inflated, lateral furrows and thickened borders conspicuous, the anterior parts between the exits of the facial sutures and the axial furrows flat, wide and joining squarely. Eyes subellipsoidal in shape, sunken within their surrounding furrows, rather widely apart, the anterior tubercles, forming the circlets around the eye furrows, large, visual area depressed; posterior branches of the facial sutures run from the back of the eye in a slightly oblique curve; genal angles rounded; axial furrows conspicuous. Thorax transversely oblong, twice as wide as long, sparsely granulated. Pygidium triangular, much wider than long (30:18), finely granulated. Axis gently convex, medially subdepressed; rings apparently twenty-four in number, continuous, segmented portion ending bluntly before the margin is reached, the remainder appearing to be joined to the pleurae of the side lobes; no tubercles visible along the medial line. Side lobes made up of eleven pairs of pleurae, or perhaps twelve, moderately convex, deflect mildly from the axial grooves, their backward curve is gentle and regular, anterior pair conspicuously faceted, their marginal ends are chisel-like. *Dimensions*: Total length, 52; length of head, 16; length of thorax, 18; of tail, 18; width of thorax, 34; spread of thoracic axis, 10 mm.

This species shows some resemblance to *E. mitchelli* Foerste, but differs in quite a number of features as follows: The eyes of our species are wider apart and are ellipsoidal instead of circular, as well as less prominent; the tuberculation of the cephalon generally is coarser, less prominent and orderly arranged; its pseudo-glabellar lobes are larger and more quadrate in shape; the spaces between the posterior branches of the facial sutures and the posterior furrows of the cephalon are wider and these furrows are narrower in *C. robustus;* the parts of the free cheeks between the emergence of the axial grooves, and the facial sutures in front of the glabella are flat, not lobed; the axial rings of the pygidium are continuous; tubercles appear to be absent along the medial line of the pygidium. These differences appear to warrant its separation from *E. mitchelli.* It may be noted further that the head of this species bears more than a passing resemblance to the head of *Encrinurus* (*Cromus*) *bohemicus* Barr., but is easily separated from

that species. It is quite possible De Koninck made his determination of the presence of *C. bohemicus* in the rocks of New South Wales(Mem. Geol. Surv. N.S. Wales, Pal. No. 6), from a head of the present species, mistaking it for the Bohemian species. It is easily separated from all other Encrinurids which have come under the writer's notice.

Loc. and horizon.—Limestone Creek, near Goodyer's hut, on the Yass-Burruwa Road, Parish of Bowning, County of Harden. Lower Trilobite Beds, Bounyongian Series.

CRYPTONYMUS PERANNULATUS, n.sp. (Plate x., fig. 4.)

Pygidium triangular, moderately inflated, apparently smooth and wider than long (12:10). Axis very slightly convex, and very slightly elevated above the side lobes, from which it is separated by faint axial grooves; it possesses about forty-four continuous rings, reaches the posterior margin, greatest width 3 mm., or one-fourth of the anterior width of the pygidium. Side lobes show thirteen pairs of segments; the posterior inclination of the segments is mild and they terminate at the margin with straight edges; the deflection of the pleurae from the axial grooves is steep throughout and posteriorly almost vertical.

The other parts of this species have not been determined; but the features of this pygidium are so clearly different from all pygidia of the genus which have come under my observation, that I have no hesitation in giving it specific rank.

Associated with this pygidium there occur several cephala and pygidia as well as some free cheeks which were referred to by the late R. Etheridge and the writer some years since; and it is possible that the cephalon and free cheek described and figured by these writers (Proc. Linn. Soc. N.S.W., xl., 1915, Pl. lvi., figs. 7, 9) belong to the species now under discussion. The free cheek in question was then placed with *E. etheridgei*, but evidence now available discloses that it does not belong there, because the facets of the eyes are very fine and numerous, while the facets of the eyes of *E. etheridgei* and of the Bounyongian Encrinurids generally are relatively few in number, large in size and less conical in shape.

Loc.—Gurnett's farm, three miles west of Bowning township.

CRYPTONYMUS ANGUSTUS, n.sp. (Plate x., figs. 5, 6.)

Pygidium (testless), which is the only part known for certain, acutely triangular, finely granulated, high anteriorly, and strongly drooping posteriorly, longer than wide. Axis made up of some 30 or more continuous rings, narrow, its anterior width being one-fifth of the anterior width of the pygidium, reaching to the margin, ending bluntly; axial grooves faint. Side lobes made up of twelve pairs of pleurae, the first pair only being geniculated, the others deflect strongly from their origin to the margins, and all have an increasingly oblique direction posteriorly. The axis is very prominent anteriorly, but gradually becomes less so posteriorly, until before the margin is reached it is inconspicuous. Dimensions: Length, 13; width, 10 mm.

The outstanding features of this pygidium are its narrowness; steep, adpressed sides; narrow, anteriorly elevated axis; few and inconspicuous tubercules along the medial line of the axis. It is plain, from the axis of this pygidium, that the axis of the thorax of the species would be narrow, and also that the glabella would be narrow, at least posteriorly; and such a glabella was obtained from Gurnett's selection, and tentatively placed (Proc. Linn. Soc. N.S.W., xl., 1915, pp. 672, 673, Pl. lv., figs. 7, 8) with *E. etheridgei* E. and M. because of its

resemblance to the cephalon of that species, and there, for the present it must remain.

It must be noted too that the pygidia previously figured (*loc. cit.*, pp. 673, 674, Pl. lv., figs. 9, 10) resemble, in several particulars, the one under review, but they are approximately as wide as long, with wider and inconspicuous axes, and thirteen pairs of pleurae.

It may be pointed out here, that the pygidia from Gurnett's selection are of different types from those of the trilobites from the adjacent Bounyongian Series. This probably indicates some difference in the geological horizon of the two places.

Loc.—Gurnett's selection, west of Bowning.

ENCRINURUS FRONTALIS, n.sp. (Plate x., fig. 7.)

Only a cephalic shield, minus the free cheeks, is known. The specific characters are:—Glabella subpyriform, front margin semicircular, width in front greater than the length, tuberculate, tubercles varying in size, arranged subconcentrically, except for a row in front of the neck furrow which is transverse; on each side are four conspicuous tubercles (possibly there were five originally), some of which are surmounted by a smaller one and separated from each other by pronounced pseudo-glabellar furrows; neck-furrow narrow and deep, its lateral extensions also deep; neck-ring strongly arched, bearing a conspicuous tubercle at each point of origin and between these are a few inconspicuous ones; lateral extensions narrow and prominent, bearing a few faint granules. Fixed cheeks of moderate size, inflated, nearly as high as the glabella, tubercles in oblique rows, separated from the glabella by deep axial furrows; eyes circular, facets rather large, visual surface depressed, distinctly separated from the cheeks by a well defined furrow. Facial sutures of the usual character for the genus. Free cheeks unknown.

This fragmentary head resembles *Encrinurus mitchelli* more than any other *Encrinurus* known to me; but it differs from that species in having the glabella wider than long; the eyes wider apart; an additional row of tubercules between the eyes and the axial furrows; the neck furrow and its lateral extensions deeper and the latter at least narrower; fixed cheeks more inflated; glabellar lateral lobes and furrows more distinct; glabella more tumid and its tuberculation more crowded, irregular and prominent. These differences are ample to separate these two species. It also resembles *E. punctatus* Brunn. more closely than does any other Australian Encrinurid.

Loc. and horizon.—A quarter of a mile south of the Bowning public school. Associated with *Dalmanites* (*Hausmannia*) *meridianus* E. and M., *D. loomesi*, etc. This is the only *Encrinurus* which has been obtained from the Middle Trilobite Beds of the Bounyongian series.

CRYPTONYMUS (ENCRINURUS) DUNTROONENSIS E. and M. (Plate x., figs. 10, 11.)

Encrinurus duntroonensis, Proc. Linn. Soc. N.S.W., xl., 1915, 670-1, 674, 675 (*b* and *c*), Pl. lv., figs. 13, 14, Pl. lvi., figs. 11, 13. The two pygidia, previously described (*loc. cit.*) and thought to be specifically distinct from the cephalon described as *E. duntroonensis*, are now regarded, with an additional two specimens, as belonging to the same species. The axes of two of the four pygidia under examination appear to have suffered compression. The following is the description of the normal pygidium: Triangular, slightly wider than long (8:7), granulation faintly indicated. Axis moderately prominent, rings thirty or more, con-

tinuous; posteriorly the axis droops steeply and ends at the margin closely invested by the terminal pair of pleurae; axial grooves faint. Side lobes strongly inflated, fulcra close to the axial grooves, from thence the lobes deflect almost vertically; each pair of pleurae from the second to the ninth pair posteriorly has a decided *f*-like shape; apparently there are twelve pairs of pleurae, certainly eleven, ending at the margin with a straight edge, and the whole pygidium has the form of an equilateral triangle. Dimensions: Length, 7; width, 8; height, 3; anterior spread of axis, 2.5 mm. A compressed specimen has length 7, width 5, spread of axis 2 mm.

That the pygidia formerly referred to (*loc. cit.*), and again described above, belong to *Encrinurus duntroonensis* seems a reasonable conclusion because they are the only pygidia found associated with the cephalon on which the species was established, and the glabella of the type cephalon is narrow, and consequently, the axis of its thorax and pygidium must also have been (unusually) narrow as is the case with the pygidia under notice; for these reasons I place them with that species without hesitation.

The pygidia of Silurian age from Europe most closely resembling these now under notice, are those of *Encrinurus seebachi* Schmidt, which agree in shape, proportionate length to width, and number of rings in the axes; but the local ones have a larger number of pleural segments, and these slope much more steeply from the axial grooves to the margin than do those of *E. seebachi.*

Loc. and horizon.—A small creek near Duntroon homestead, Parish of Canberra, County of Murray. Upper Silurian or perhaps older.

ENCRINURUS MITCHELLI Foerste. (Plate x., figs. 12, 14.)

Encrinurus mitchelli Foerste, Bull. Sci. Lab. Denison Univ., iii., Pt. 2, 1888, p. 124, Pl. xiii., figs. 2, 3, 20.—(?) *Cromus murchisoni* De Koninck, Foss. Pal. Nouv. Galles du Sud, 1876, Pt. 1, Pl. l., fig. 9 (exclude figs. 9*a* and 9*b*).—*E. mitchelli* Etheridge and Mitchell, Proc. Linn. Soc. N.S.W., xl., 1915, pp. 657-662, Pl. liv., figs. 1-5, Pl. lv., figs. 1-3, 15, Pl. lvi., figs. 2, 10, Pl. lvii., fig. 9.

A careful study of a large number of specimens of this species enables me to add an important point or two to former descriptions. In the original description by the late R. Etheridge, junior, and Mitchell the axis of the pygidium is said to terminate mucronately and to possess twenty-six rings; but instead of that some well preserved pygidia show that it ends in a fairly fine, rounded point in front of the submucronate terminal formed by the coalescence of the last pair of the pleurae; and that it bears thirty-two annulations, or more, in mature specimens, also, in the description referred to, doubt was expressed whether there were ten or eleven pairs of pygidial pleurae. It may now be stated definitely, that in all specimens of the species which do not exceed 1½ inches in length, the pygidial pleurae consist of ten pairs and for mature specimens which reach a length of two inches or a little more, eleven pairs is the normal number.

ENCRINURUS SILVERDALENSIS Etheridge and Mitchell. (Plate x., fig. 13.)

Encrinurus silverdalensis E. and M., Proc. Linn. Soc. N.S.W., xl., 1915, pp. 665-667; Pl. liv., fig. 11; Pl. lv., figs. 4, 9; Pl. lvi., fig. 4, 5, 6, 14; Pl. lvii., figs. 3, 10.

In the original description of this characteristic *Encrinurus* it was stated that the thorax and pygidium were finely granulated. Later evidence proves that these parts were coarsely tuberculate in a way which makes it easily distinguishable

from all other Australian species of *Encrinurus*. Also (*loc. cit.*) it was stated that the axis of the pygidium is made up of thirty or more annulations; but a well preserved and approximately mature specimen of the species shows it to have only twenty-six rings and that the axis does not quite reach the posterior margin, and subtending its termination is a short convex piece between the posterior pair of pleurae. Another important feature about this species is, that the posterior pleurae of the pygidium are strongly folded under the margin. This feature does not occur in any other *Encrinurus* yet described from Australia.

An additional reference to CORDANIA GARDNERI Mitchell.

Since the publication of the paper in which this trilobite was described (Proc. Linn. Soc. N.S.W., xlviii., 1922, pp. 535-540, Pl. liv., figs. 1-7) Mr. T. H. Pincombe had the good fortune to find an almost perfect specimen of the species which he kindly passed on to me for study. This specimen (Plate x., fig. 15) permits the following modifications of the original description: The form of the eye is sublunate rather than reniform; the axis of the thorax is practically as wide as the combined width of the two side lobes; and the genal spines reach to the fifth thoracic segment.

Family BRONTEIDAE.

BRONTEUS (GOLDIUS) SINGULARIS, n.sp. (Plate x., fig. 8.)

In my collection there is a nearly complete thorax of a trilobite which I have placed in the genus *Bronteus*. Its description has been withheld for many years, hoping that some better specimens of it might be secured.

The specimen shows an almost complete axis and the two side lobes of a thorax, with, on one side, several appendages attached to the pleurae; these parts closely resemble *Bronteus*, but the thorax seems to have eleven rings, an unusual number for the genus. One of these rings may, however, be the neck-ring. There are three almost complete appendages of the pleurae on the left side, and three others of which proximal parts only remain. The side lobes and the mild convexity of the axis are characteristic of the *Bronteus* group. The axis and side lobes are approximately of equal width and some of the segments bear on their surface, striae such as are found only on *Bronteus*. The appendages of the pleurae are subsickle-shaped. Dimensions: Length of thorax, 20 mm.; width, 18; width of axis and of the side lobes, 6 mm.

The present determination of this fragment is only a tentative one and made largely for the purpose of drawing attention to it.

Loc. and horizon.—Lower Trilobite Beds of the Bowning Series, Minahan's selection, Bowning Creek.

BRONTEUS PLATYNOTUS, n.sp. (Plate x., fig. 9.)

The only specimen of the species known is a whole individual, but unfortunately the head is turned under the thorax, and most of it is hidden. From the portion of it exposed, the following particulars are noticeable: Battle-axe-shaped, very mildly convex, adorned anteriorly with concentric striae only visible under a lens, and laterally, at least, these are crossed by coarser anastomosing lines. Eyes reniform, large, faceted. Neck-furrow narrow; neck-ring stout. Thorax evidently consists of ten segments, which are transversely striated, mildly convex, oblong and twice as wide as long. Axis mildly convex, relatively wide, its spread being equal to the combined width of the side lobes; axial furrows faint. Pygidium large, oblong-semicircular, slightly convex, adorned with very fine

STUDIES IN PARASITISM.

i. A Contribution to the Physiology of the Genus Cassytha. Part i.

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(*Contribution from the Botanical Laboratory, University of Sydney.*)

(Plate xi., and thirty-two Text-figures.)

[Read 26th March, 1924.]

Introduction.

Parasitic Angiosperms have generally proved of considerable interest. They were probably originally free-living forms which subsequently took to a dependent existence. Various forms indicate degrees of parasitism varying from the water parasites such as *Viscum, Arceuthobium* (Pierce, 1905) and *Loranthus* to such pronounced and complete parasites as *Cuscuta, Phoradendron, Balanophora*, etc. Pierce (1894) has furnished a complete account of the physiology of the genus *Cuscuta*, a climbing parasite which develops haustoria into its host in order to obtain food and water. It possesses little chlorophyll and is dependent absolutely upon its hosts. The fact that the various flowering clusters, situated in relation to haustoria, may be severed from one another and yet flourish, suggests this view; *Cassytha*, however, while resembling *Cuscuta* in its mode of twining and coiling, and its development of haustoria, differs radically from it, in the possession of chlorophyll, and in the fact that the haustoria mainly withdraw water from the hosts. *Cassytha*, therefore, is intermediate in position between an independent, leafy, climbing plant and the complete parasite, *Cuscuta*. This fact suggested the desirability of making a complete study of the New South Wales representatives of the genus; and of comparing them with *Cuscuta australis* and with the results which Pierce, Koch (1874) and others have obtained for *C. glomerata, C. europea*, and *C. epilinum*.

The material used for my work included four species of *Cassytha, C. glabella, C. paniculata, C. pubescens, C. melantha;* and one species of *Cuscuta, C. australis*, a small, leafless, thread-like form. These parasites belong to two quite distinct orders, the former to the Lauraceae and the latter to the Convolvulaceae. This fact adds interest to the investigation of the physiology of *Cassytha*. Many observations and experiments were made upon the plants growing in their native habitat under perfectly natural conditions. The field experiments and observations were supplemented by laboratory experiments on plants raised from seed in pots. The seedlings of each species were grown under two sets of conditions, namely, in pots exposed to sun, rain and wind, and under a bell-jar where the warmth

and increased humidity produced accelerated growth. *Cassytha* has an advantage for experimental work over *Cuscuta,* in the fact that it is a perennial form and lives generally upon perennial hosts, so that it is possible to continue the experimental work almost indefinitely, and make observations upon the seasonal variations of the parasite.

In 1846 Decaisne published a paper on "Structural Anatomy of *Cuscuta* and *Cassytha,*" while in 1877 the haustorium of *Cassytha* was studied by Poulsen, whose paper unfortunately I have not been able to obtain. In 1904 Böwig studied *Cassytha filiformis,* and Mirandé (1905) published a paper entitled "Cassythacées." Ewart (1919) studied the germination of the seeds of *Cassytha melantha.* This represents the extent of the bibliography upon *Cassytha.*

General description of Plant.

Cassytha is a small genus of the Lauraceae and includes a most interesting group of parasites. There are five species which occur as long, thread-like, twining plants throughout New South Wales from the coastal districts to the tablelands and throughout the plains. The various members of the genus climb by a twining movement. There are no tendrils produced, but the apex of the plant circumnutates—and by this nutation and the probable assistance of the wind, is carried against adjacent plants. The experiments described later will show the influence of circumnutation and irritability to contact and gravity upon the spreading and development of the plants.

Some species of the genus have relatively stout stems, others are thin and glabrous. The leaves are absent or reduced to scales and the stems function as the photosynthetic organs.

In *C. glabella,* the smallest species, the stems are delicate, thread-like and perfectly glabrous. *C. pubescens,* quite a large species, has a thick covering of brownish hairs, especially on the younger shoots. The species are typically reddish tinted. The older stems frequently retain the hairy covering. The hairs are also present in large numbers on the surface of the fruit. The stem of this species has a peculiar, irregular surface contour. *C. paniculata* has fairly stout stems, but, like *C. glabella* and *C. melantha,* is perfectly glabrous.

C. melantha is the coarsest species of the genus, frequently exceeding 3 mm. in diameter. The stems are glabrous. All the species branch considerably, but this condition is particularly evident in *C. melantha* where three branches generally develop from a node—the main stem and two large lateral branches. In all forms the lateral branches arise from a bud protected by scale-like leaves. In *C. glabella* the leaves are extremely small; they are largest and most conspicuous in *C. melantha.* The great reduction of leaf surface is probably an indication of xerophily, as one would naturally anticipate in plants which are water parasites. The plants branch profusely and some produce a tangled mass of branches hanging upon any plants they have been able to reach.

The spiral coils formed round the branches and leaves of plants are sometimes loose, sometimes close, and the haustoria which attach the parasite to the host are numerous. These penetrate into the wood of the host and the stimulating cause (as experiments described later prove) is the continuous contact of the stem with the branch or leaf or petiole of the host (Fig. 1).

The flowers of *Cassytha* are hermaphrodite and small. The calyx consists of six persistent segments. There are 9 functional stamens and three staminodia arranged in two whorls of six. The calyx-tube encloses the gynoecium, which terminates a small lateral shoot. There is a single ovule. In all the species the calyx tube becomes considerably enlarged and succulent, particularly so in *C.*

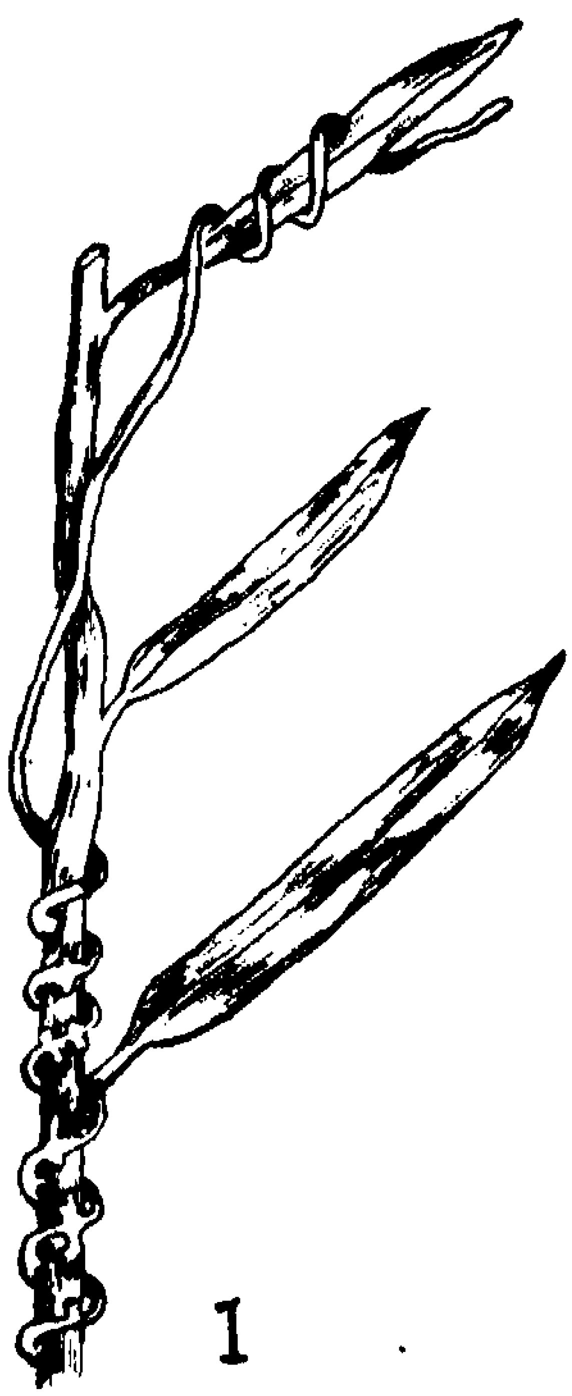

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Fig. 1.—Portion of parasite on a twig showing the alternation of loose and close coils, and the distribution of the haustoria on the closely coiled zones. (Nat. size.)

glabella, the fruit of which is red or yellow. In the other species the fruit is green and comparatively succulent—e.g., *C. pubescens.* The flowers terminate short lateral branches in *C. glabella,* but in *C. pubescens* and *C. melantha* they are crowded in short spikes. In *C. paniculata* and *C. phaeolasia* the flowers are arranged in elongated spikes some distance apart.

In the New South Wales Cassythas a succulent fruit is developed, which probably assists in dissemination by attracting bird life, although in nature I have found numerous fruits germinating beneath the dense tangle formed by the parasitic branches. The succulent tissues decay rapidly, and by absorbing water and retaining it, assist in the germination of the seed. The fruit, like other parts of the plant body, contains numerous large cells filled with an extremely mucilaginous cell sap, which is capable of considerable absorption of water. The putrefying tissue of the fruit, therefore, furnishes an extremely satisfactory matrix into which the young root rapidly penetrates on germination of the seed.

In each fruit there is a single globular seed; at its apex the remains of the style and stigma persist. The seed of most species is covered by numerous short hairs which are developed from the hard, black, rather stony seed-coat.

Within the seed-coat is a whitish-yellow endosperm containing starch and oil and mucilage, and embedded in the centre of this nutritive tissue is the small embryo.

The seed-coat consists of three distinct layers: an outer hard, brownish-black, stony layer, often pubescent; a central zone of clear cells elongated considerably at right angles to the surface; on the inner limit of this zone is a narrow layer of cells with thick mucilaginous walls. The thickening is laid down on the cell wall; when placed in water the cells swell and stretch in a radial direction. This property of the mucilaginous layer assists in the germination of the seed.

Cassytha arises from a seed which germinates in the soil, and the young seedling develops normal roots capable of absorption. The apex of the seedling circumnutates, and comes into contact with portion of a plant round which it coils. Then haustoria are developed, and penetrate the tissues of the host. When a number of these haustoria are developed at intervals along the stem, and the water supply is secured, the lower part of the plant dies away; so the older plants of *Cassytha* have no relation to the soil. I have examined numerous tangled masses of various Cassythas and in no case could I detect connection with the soil or a normal root system.

Physiologically there is no necessity for absorption from the soil, directly, by the parasite, if it can obtain an adequate supply from the xylem tissues of its host, and the absence of this soil relation directly affects the structure and development of the conducting system.

Furthermore, the spiral coiling of the branches of the parasite round the

host twigs (and leaves) and the development of numerous haustoria in these coils bring every part of the xylem tissue of the host under contribution. So effectually is this done, that the younger twigs and branches of a host-plant often die owing to the scarcity of water; when this occurs, the parasitic branches producing this effect appear to receive water from other parts of the body, continue to grow, and soon attach themselves to other branches. Frequently, however, the parasite dies away on dead branches of the host. The dead parts of the parasite soon lose all their cell contents, which are removed by the active parts for growth of more favoured branches, and shrivel away to a mere shell which is cut off from the living parts by a formation of callus.

In nature the apices of young shoots, being very turgescent and soft, are often damaged; when this occurs, the quiescent buds further back develop and continue the general growth of the shoot. Although (as I shall demonstrate later) conduction of water sometimes takes place over considerable lengths of the parasite, this is not the normal condition in the economy of the parasite; and, if certain branches cannot support themselves by drawing upon their living supports for their necessities in the way of raw materials, they are severed physiologically from the rest of the body. The explanation of the death of numerous branches of the parasite upon dead parts of their host is to be found in the inadequacy of the conducting tissues of the main stems of the parasite to meet the demands of a much-branched and very elongated body.

All the species of *Cassytha* are perennials, and, while they may be parasitic on annuals, their main hosts are perennials. For some time the young seedling plants are parasitic upon grasses, and small herbs such as *Sonchus, Stylidium, Senecio*, etc., but rapid growth and development soon carries the parasite's shoots to larger hosts—which in the Australian bush are evergreens. Along the coastal districts, where the difference between summer and winter temperatures is not very great, there is a certain amount of growth throughout the year. Indeed, in a large number of plants the greatest growth occurs during the cooler, more moist days of late winter and spring. Throughout the year, therefore, there is always some sap flowing, and the parasite is certain of being able to obtain a supply of the necessary water and salts from its host. In all its various hosts, there is a sudden burst of great growth-activity in the spring, culminating in flower production, and it seems probable that the parasite obtains an amount of organic substance from its host during this period when plastic food materials pass along the vessels. At any rate, there is frequently an interesting coincidence in the flowering period of the hosts and the parasites.

The parasites continue flowering for several weeks, and one commonly finds flowers and fruits at the same time. The seeds take 4 to 5 weeks to germinate and, by the end of 8 weeks, the seedlings are from 10 to 30 inches long.

All the species of *Cassytha* grow rapidly upwards. They branch profusely. The smaller parasites do not twine around a support of greater girth than 2.5 cm., but *C. melantha*, the largest species, coils round the stems of hosts fully 4 cm. thick. The coiling, however, is loose, the spirals being from 2½ inches to 1 inch apart, and few haustoria are developed. When the parasite is utilising such thick supports, it branches less frequently, and generally strikes out along the first branch of smaller diameter. When the supports are thin, the close coiling is frequent, and the haustoria numerous. Once the parasite reaches the upper branches of its host, it multiplies the number of its shoots, grows rapidly, and soon envelops the foliage and twigs of the host in a mass of tangled threads which withdraw their contribution of raw materials. The lower parts of the

parasite frequently become yellowish and etiolated, owing to the lack of necessary light for chlorophyll formation, and since the food synthesised by the upper portion of the parasite tends to gravitate towards the young apices, the lower branches are starved and soon wither. The parasite flourishes on the upper illuminated branches of its host and spreads out in all directions from such a centre of infection, in search of new sources of food materials.

Habitat of Cassytha.

Cassytha seems to develop most successfully in shaded gullies where hosts are closely crowded and there is considerable moisture. Light appears to have a dominating influence upon its development, as young seedlings, which have found hosts in the smaller plants of the undergrowth of the dense formations, grow extraordinarily rapidly, and soon spread upwards to the taller plants around. The tendency during early growth appears to be upwards to the tops of the small bushes and shrubs which form its hosts; once on the top, the parasite spreads outwards to all points of the compass and soon becomes attached to other hosts. The flowers are always produced upon the parts of the parasite exposed on the upper branches of the various hosts. The fruits of *Cassytha* drop on to the moist, shaded substratum beneath the hosts, the pulpy mass rapidly decays and the seeds germinate. This habitat appears to be the most favourable for the development of the young seedlings of the parasite, and under such conditions of moisture and shade, the growth is extraordinarily rapid. Where, on the contrary, the seeds germinate on more exposed, sunny situations, growth is not so rapid. Species of the parasite developing on hosts found on the exposed dry tablelands of the Blue Mountains are less virile: individuals of the same species occurring in the sheltered, moist, marshy spots on the slopes, not scorched by the sun are much more vigorous. The slender, less luxuriant forms on the more exposed sunny habitats are probably due to the stunted condition of the hosts, the lack of water and the retarding effect of the intense insolation. That *Cassytha* flourishes most successfully under shaded moist conditions is supported by my observations in the laboratory. One series of seedlings, growing in pots covered over with a large bell-jar, to create a humid atmosphere, showed undoubtedly greater rapidity of growth than unprotected seedlings of the same age.

From observation and cultivation in the bush, and from germination of the seed in the laboratory, there is evidence that *Cassytha*, in its early development at any rate, requires a moist, sheltered habitat. In such a situation the loss of water by transpiration is not great, and the reduced root-system of the seedling absorbs sufficient water to maintain the necessary turgidity of the growing apices, which is indispensable for rapid growth. Where *Cassytha* occurs on the sandstone among highly xerophilous hosts, it passes through the early stages of development rapidly when the moisture factor is favourable, and attaches itself securely to its hosts.

Experiment indicates that the most favourable habitat for the development of the seedlings of *Cassytha* is a moist warm soil and atmosphere such as is developed under a bell-jar in the sun.

Hosts of Cassytha.

From observations in the field and laboratory experiments, it appears that this genus lives and flourishes upon any host, and parasitism within the genus has not developed to the degree of selective parasitism, or preference for certain hosts.

To mention cases in point, I have observed a mass of *C. melantha* parasitic upon *Pittosporum* sp., *Hakea dactyloides*, *Persoonia salicina*, *Acacia discolor*, and

a species of *Casuarina* growing together. Near by, another mass of the parasite was twining upon *Leptospermum stellatum*, *Lasiopetalum ferrugineum*, *Xerotes longifolia*, *Xanthorrhoea* sp., and numerous small grasses and herbs forming the undergrowth. Other hosts on which I have found species of the parasite are *Ceratopetalum gummiferum*, various species of *Leptospermum*, *Persoonia*, *Casuarina*, *Acacia*, other than those enumerated above, *Grevillea sericea*, *G. robusta*, *G. buxifolia*, *Callitris cupressiformis*, *Schinus* sp., *Loranthus longiflorus*, *Pteridium aquilinum*, and *Cryptomeria japonica*. Indeed, from my field observations, I have not the slightest doubt but that the various species of *Cassytha*, particularly *C. glabella*, *C. paniculata*, *C. melantha*, and *C. pubescens*, are capable of growing upon any host which they can reach, and about which they can twine.

Probably no stronger evidence of the remarkable adaptability of the parasite can be furnished than examples of its parasitism upon other parasites. I have found the branches and leaves of *Loranthus longiflorus* encircled by the threads of *Cassytha* and many close coils were made on each little branch. Each coil had numerous haustoria, which were larger generally than those produced upon many other hosts. Moreover, owing to the fact that all the species of *Cassytha* are capable of encircling any object, provided it is not too thick and induces contact-irritation, one might expect that *Cassytha* would twine about itself. In its natural habitat it is quite a common occurrence to find two or three branches of the parasite closely entwined, and with fully developed haustoria just as numerous as upon other hosts. Experimental proof may be advanced in support of these observations. Young branches of the parasite were carefully fixed in a pendent oblique position. Within six hours the apex had curved into a vertical position, and begun to circumnutate; in from three to six days, the time varying according to the length and the degree of sensitivity of the branches used, the apex had coiled around the pendent part of the parasite's branch and haustoria were developed in the close coils formed. The fact, that *Cassytha* will develop haustoria upon any host, from the small annual herbs to the large perennial species of *Eucalyptus*, *Persoonia*, *Grevillea*, *Pittosporum*, *Acacia*, *Casuarina*, etc. of the Australian bush, upon plants with smooth or rough bark, upon leaves with thick or thin cuticles, hairy surfaces, upon plants with abundant latex, oxalate of calcium crystals and other substances generally injurious to haustorial development, and even upon itself, points irresistibly to the conclusion that the various species of *Cassytha* do not possess any particular chemotropic sensitivity and do not respond to particular substances or concentrations of substances in the plants upon which they are parasitic. Were the haustoria developed as the result of chemical stimulus, one would naturally expect the confinement of the parasitism of *Cassytha* to particular hosts, in which certain chemotropic compounds are present. At any rate, one would expect the absence of auto-parasitism. Auto-parasitism, however, while indicative of a low grade in parasitic specialization, is correlated in this genus with the physiological demands made by an extremely attenuated body. If the plant is able to draw upon certain portions of its own body by haustorial action, it will naturally obviate, to a certain extent, the necessity of conduction through considerable distances, and supplies of water and nutritive solutes will be more readily accessible to the young, actively growing parts. Indeed the problem of conduction throughout a thin climbing organism is a difficult one, but seems to be satisfactorily met by this auto-parasitism. Moreover, each section of the plant may be considered to be almost independent of the rest, for the haustorial connections are all that are necessary for the supply of water and solutes

to the parasite. No connection with the soil is essential when the plant has once established an intimate association with some host.

The apex of the shoot.

The young shoots and the apices of seedlings are typically yellowish-green: some are pubescent, others are perfectly glabrous. They contain little chlorophyll and therefore photosynthesis is feeble or non-existent, as indicated by the evolution of oxygen. Studies of the young shoots in section show that very few chloroplasts are present in each of the cortical cells, and also that numerous small spherical starch grains, mucilage and oil occur in the cells of the cortex, xylem-parenchyma and pith, to within a few centimetres of the actual tip of each branch. This reserve material may have been translocated from older, photosynthetic regions of the stem and accumulated for the periods of intense physiological activity, namely, growth in length of the shoot, followed later by close coiling, and haustorial development.

All the older parts of the plant growing in shaded situations are typically dark green, particularly so in *C. glabella*, *C. melantha*, and *C. paniculata*. In *C. pubescens*, the stems are coated with brownish hairs which somewhat obscure the green colour, while exposed plants of all species, in bright sunlight, are frequently yellowish-green. In sections of all older stems of the various species of *Cassytha*, made in the autumn, there is a great accumulation of reserve foods in the parenchyma of the body. This is an indication that consumption, even during the active vegetative period of the summer months, has not been as great as the supply, and that the stem is comparatively efficient in photosynthesis.

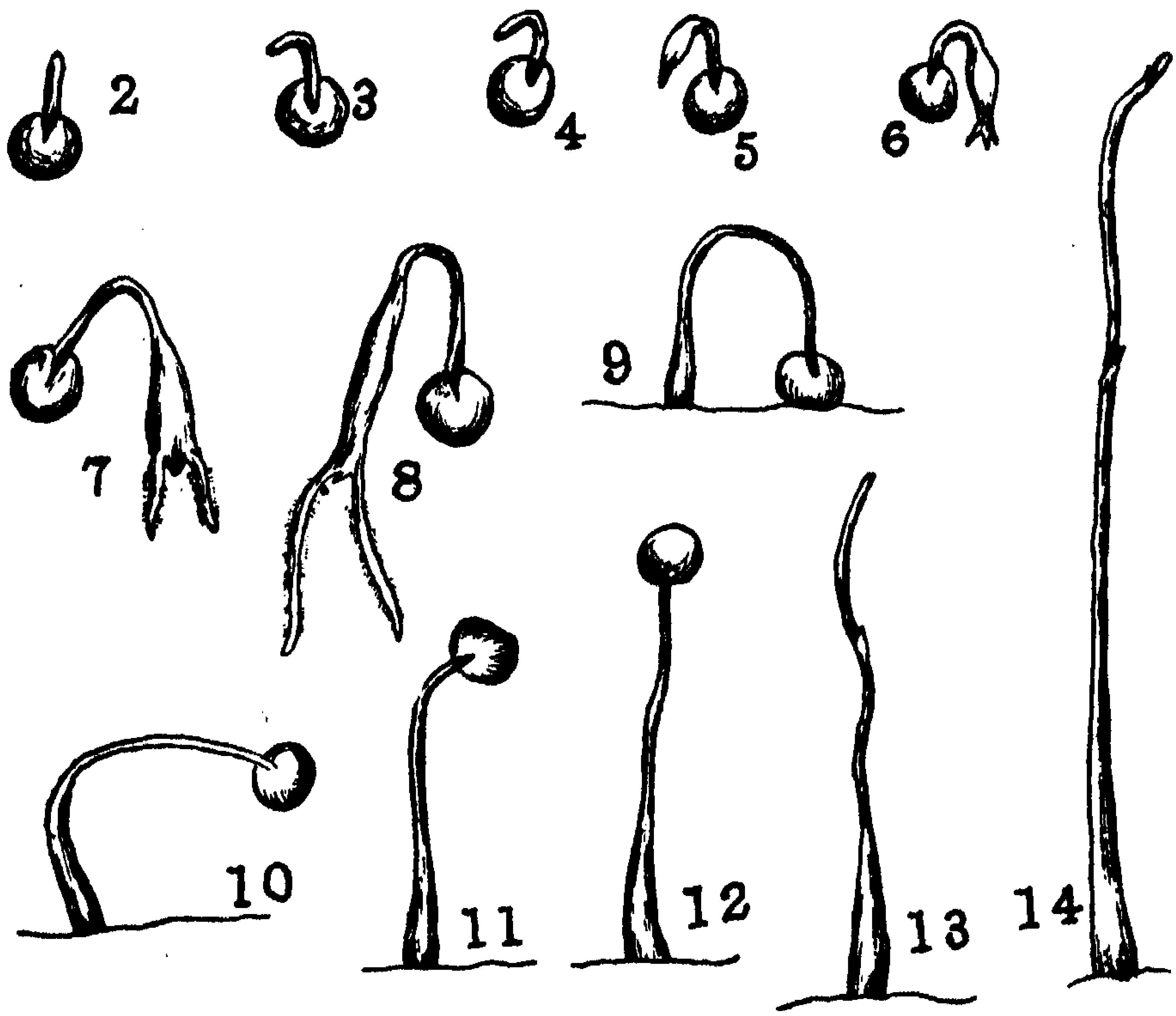
The Seedling.

Ewart (1919) has described the germination of the seed of *C. melantha*. For the sake of completeness I give my observations fully although a re-examination confirms the previous work. As Ewart has observed there are *no cotyledons* on the embryo.

The fruits of *C. paniculata*, *C. glabella*, and *C. pubescens* were placed in flowerpots containing loam. In a few days the fleshy part of the fruit became brownish in colour, and decayed into a pulpy mass leaving the small black seed lying in the putrefying matrix. The latter probably serves the purpose of holding moisture around the seed until it germinates. At any rate the seed obtains water either from the soil, or from the decayed fleshy covering of the fruit, its walls swell, the entire seed becomes quite turgescent, and the minute wrinkles on its outer surface are smoothed out. After 4 weeks the root appears as a small, conical protuberance which emerges from the micropyle. In numerous cases of germination the root grew upwards, slightly above the soil level, and then curved downwards towards the soil. The main root of the seedling is strongly positively geotropic, as when it is placed in any but the normal position, a positive curvature results. It is at first like an ordinary root of any other plant, and is only a few millimetres long, but in the course of the next few days, when it has placed itself in the proper relation to gravity and the soil, the base of the stem becomes swollen, owing to the transfer of food from the endosperm of the seed (Figs. 2 to 14). This absorption of food is carried on by the stem apex, which is in the closest intimacy with the surrounding endosperm, especially at the extreme apex.

While the foods are being transferred to the root and the base of the stem, the latter elongates and becomes swollen to many times its original thickness and, with the root, forms a U-shaped bend. The main root continues to elongate very slightly and becomes swollen, like the lower stem, with foods withdrawn from the

endosperm. No root hairs are developed from this primary root, so that up to this stage no water has been supplied to the embryo except that absorbed by the seed coats (Figs. 6, 7, 8). The root of *Cassytha* differs from the seedlings of other plants which early develop root-hairs. Several (usually three) lateral roots arise 2 or 3 mm. behind the tip of the main root, from the swollen, tuberous part and enter the soil obliquely; these develop the short root-hairs characteristic of the parasite (Fig. 8).



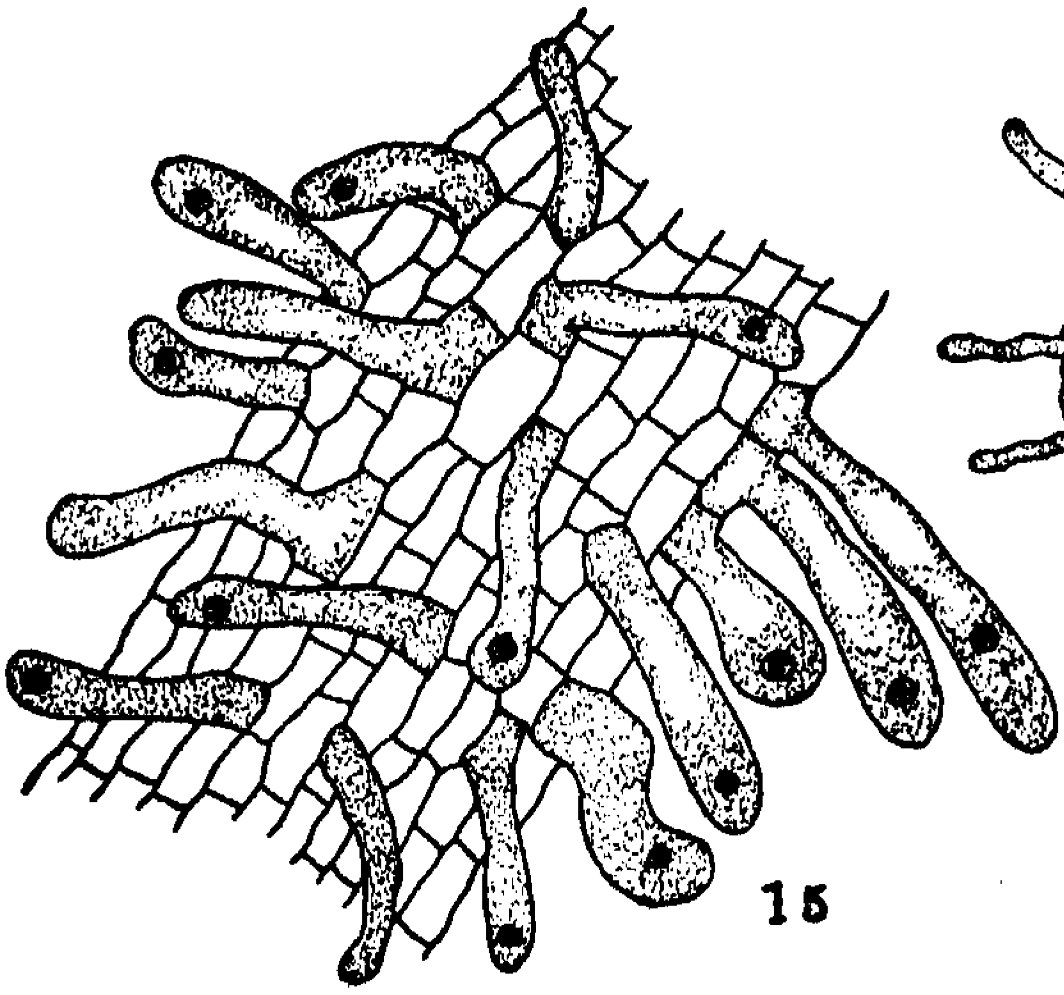
Figs 2 to 14.—Stages in the development of the seedling, showing the development of the swollen primary root and base of the "hypocotyl" and the early assumption of the vertical position. (Nat. size.)

In experimental seedlings which had attained a length of 20 to 32 cm., six short white rootlets were developed, each from 2 to 5 cm. long. The root-hairs upon these are short, stiff, comparatively broad and unicellular. They are remarkably like the secretory cells of nectaries (Figs. 15-16). The hairs are not limited to any definite zone, but occur from about 1 mm. behind the apex to the base of the rootlet. Nearest the apex the hairs appear as short, broad, dome-shaped to conical, outgrowths of epidermal cells, rich in protoplasm. The walls are thin, the hairs very turgid and swollen. Basipetally the hairs become more mature and even the oldest hairs appear to be quite functional.

It is unusual to find so many root-hairs in the incipient stage near the growing point of a root; but this is readily understood in *Cassytha* when one considers the very slow rate of growth of the root, and also the fact that it attains to only a few centimetres in length.

Anatomy of Root.

The main primary root of *Cassytha* is short and thick, seldom more than a few millimetres in length. It is very parenchymatous and fleshy. The cortex is broad and composed of thin-walled parenchyma with large quantities of tetrahedral starch grains, and little protoplasm. Spaces occur between these cells, permitting the aeration of the root. The vascular tissue occupies the centre of the root, the xylem forms a diarch plate extending across the central region. On



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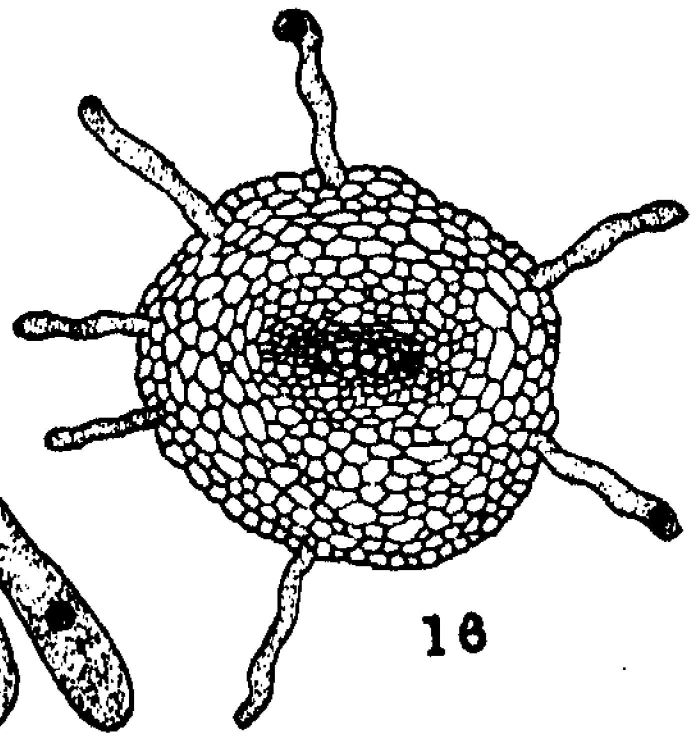

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Fig. 15.—A portion of the surface of a lateral root showing the short, thick root hairs. (x 167.)

Fig. 16.—T. S. of lateral root showing diarch stele, and the short, broad root hairs. (x 67.)

either side of this is situated the narrow band of phloem with several layers of conjunctive tissue between (Fig. 16). This layer, if secondary thickening occurred in the root of *Cassytha,* would give rise to the secondary conducting tissues. The thin, but longer, lateral roots, which arise when the hypocotyl begins to thicken, have practically a similar structure to that of the primary root, but they contain less starch. All the roots of *Cassytha* have a poorly developed root-cap. The root-system only penetrates a very short distance into the soil. The root generally grows upwards at first, then curves downwards into the soil. The "hypocotyl" forms an arch, while the stem apex remains embedded in the seed.

The entire root-system of the parasite is considerably reduced, but it seems natural that the parasitic habit of the plant should lead to a reduction of the root-system. This attaches the young plant fairly securely in the soil, and the stem portion, still retained within the seed coats, rapidly elongates and frees itself from the seed, curving obliquely upwards. The young seedling is strongly negatively geotropic, as one might expect in a climbing plant. The early growth of the seedling is extraordinarily rapid, provided that the humidity and temperature are favourable. During the first three weeks the growth attained the maximum of four to five inches in a week. At the end of this very active period, growth decreased remarkably, so much so that some seedlings only increased by two inches in the next four or five weeks. All the seedlings showed clearly this

variation in the growth, and there seems some physiological significance attached to this phenomenon. During the phase of accelerated growth the functional root provides the water necessary to mobilise the food reserves in the seed, and for the maintenance of the turgidity of the growing apex. The seedling, therefore, attains a certain length compatible with the root-system, and the amount of reserve food available. The root does not grow beyond a certain size, so, although the seedling, by virtue of its chlorophyll corpuscles, which are numerous, as the green colour suggests, may be capable of supplying itself with synthetic foods; the necessary water and salt solutions from the soil are not provided in quantities sufficient to meet the demands of the seedling. This rapid growth, moreover, will afford the parasite a stronger chance of reaching some suitable host.

In experiments with young seedlings which did not secure attachment to a host, the root died after from eight to ten weeks period of functional activity. In other seedlings which had been allowed to twine around a host, the root-system perished sooner. Later the basal portion of the young plant died away, the cell contents probably being absorbed by the more active regions of the body as occurs in *Cuscuta*, as these portions later become reduced to mere hollow shells. In the case of seedlings which were not allowed to become attached to a host, slow growth continued for about 9 or 10 weeks, amounting to a maximum of 1 cm. per week. Seedlings growing so feebly are generally unable to entwine round a host when presented to it.

The whole development and activity of the seedlings of *Cassytha* indicate that the ancestors of the present forms were a series of climbing and independent plants like many of the Convolvulaceae, the parasitic mode of life being developed as the result of acquiring great sensitiveness to contact.

The seed of *Cassytha*, though small, contains a considerable quantity of reserve foods, which must be mobilised for the nutrition of the developing organs of the young plant, and to ensure this end water is essential. The young root of the parasite is, therefore, functional at first, and provides the water required to dissolve the reserve foods of the endosperm, to translocate them to the growing stem, and to maintain the turgidity of the cells of the seedling. Although the root of *Cassytha,* like that of *Cuscuta,* is a comparatively short-lived organ, yet the mere fact, that functional roots do appear in the early development of the parasite, suggests that climbing parasitic Angiosperms at any rate are degenerates from free-living independent forms, and that the comparative simplicity of their root-system is probably the result of their dependent mode of life.

The genus *Cassytha,* furthermore, like most twining parasitic Angiosperms, was no doubt represented originally by free-living independent autotrophic organisms, which had developed the climbing habit. The parasitic mode of life, especially in *Cassytha,* as in many other climbing forms, is a derivative condition; its efficiency is exemplified in the success of the plants which have adopted it, as these gain a considerable advantage over other plants in the struggle for raw materials and light, by being freed from their competition. The advantage accruing to the parasite is not only biological but also physiological, in as much as these climbing water parasites can dispense with a considerable amount of mechanical and conducting tissues, which would otherwise be necessary. The development of haustoria makes each little part of the plant practically an independent entity, so far as the supply of water and solutes is concerned.

A seedling one inch to three inches high is practically erect, but the elongation soon causes the apical region to assume a procumbent position, with the ex-

ception of the extreme apex which is raised slightly. Mechanical tissues are absent.

Some plants which I raised in flowerpots attained a length of 30 cm. in about a month. They were removed from any object which might act as a support, and consequently straggled along the ground, the apex meanwhile executing a series of wide circular or elliptical sweeps in search of some support.

Young seedlings a few inches in length were brought into contact with small plants of various kinds so that the sensitive surface of the nutating apex was stimulated for a time. The whole circumference of the stem apex is sensitive to contact. In 2 days, two complete close coils were made around a young plant of *Sonchus* sp.; in another 40 hours haustoria were developed as very small papillae. When the haustoria have penetrated into the xylem of the host, the growth of the seedling parasite is accelerated so that its length between the last series of haustoria attaching it to the host plant and the apex, rapidly increases. There is a certain periodicity in the growth of the parasite—a period of rapid growth until a living support has been found alternating with a period when growth is slow and the parasite is developing a series of close coils and haustoria which secure a firm attachment to the host. This periodical variation in growth is advantageous in as much as it is instrumental in the spreading of the parasite.

Cassytha branches freely and spreads in all directions over the small herbaceous and shrubby plants on which it is parasitic. The last series of haustoria supply the water necessary for rapid growth of the apical region and the long terminal portion of the parasite, rapidly elongating, executes wide circumnutations and may often come into contact with new individuals which act as hosts.

A simple experiment shows that water may be conducted over considerable distances in the stem when necessary. In some of my seedlings, which were not attached to a host, the water was conducted through a distance varying from 20 to 32 cm. In experiments in the bush I removed all the lateral branches from a main, rapidly growing branch, supported the shoot carefully in the horizontal position, and in this way obtained a growth in length of between 40 and 50 cm. beyond the last series of haustoria. Such a result indicates clearly that close coiling and haustorial formation are not necessary for the growth of the plant, because water may be transported over quite considerable distances. In this remarkable group of parasites which may attain to lengths of upwards of 30 feet, conduction through considerable lengths of the stem is not the general rule, and, in fact, is quite unnecessary, owing to the very frequent distribution of haustoria supplying the necessary raw materials for each unit of the stem; but, in special cases, conduction through lengths of several feet may take place. This occurs in the young apices of the plant. These may attain to a length of several feet beyond the last series of haustoria; during their early development, that is to say, when they project a few inches beyond the support, growth is very rapid, and circumnutation is readily demonstrated, but when the free apical region attains, in the coarser species *C. melantha* and *C. paniculata*, a length of about 18 inches, it begins to droop and growth falls away considerably, although it may continue until the apex projects as much as two to three feet beyond the last group of haustoria. During this time the apex remains turgid, so that conduction, not only of water but also of plastic materials, must take place.

The Functional Period of the Root.

Pierce (1895), in his studies of *Cuscuta*, observed that the root of the seedling dies either just before or immediately after the apex has begun to twine around a host, that it seldom lives more than seven days, and that the seedling's

growth is a form of slow locomotion owing to the ability of the young part to draw upon the food of the basal region. *Cassytha* evidently differs somewhat from *Cuscuta* in this regard, for the root of *C. paniculata* or *C. glabella*, after 7 weeks, although the apex was coiled around a host, was still living. In other seedlings which had not found a host, the root persisted for a longer time. After attachment to a host, the root and the basal portion of the stem die away and their contents are transported to the growing parts. It therefore appears that the root of *Cassytha* functions for a longer period than that of *Cuscuta*. In nature the older plants have no connection with the soil. There is, in *Cassytha*, as Pierce has described in *Cuscuta*, a "form of slow locomotion," with the difference, however, that the root lives and functions for a longer period than in the more complete parasite *Cuscuta*. It is a noteworthy fact, that the root functions for a longer period in seedlings which fail to encompass a host. The longest period of activity I have actually observed for the root of *Cassytha* is two months; and this occurred in seedlings which attained a length of between 25 and 32 cm. The development of haustoria into a host and the satisfaction of the needs of the plant as regards water, seemed to cause a fairly rapid change in the relation of root to stem. The physiological requirements of the parasite are supplied by the haustoria and a normal root becomes unnecessary.

The parasite varies in thickness from the lower portion towards the growing, circumnutating apex; the younger branches are extremely thin and delicate, the apex slightly curved or hooked, so that on coming into contact with a suitable object, twining begins almost immediately. The twining is counterclockwise.

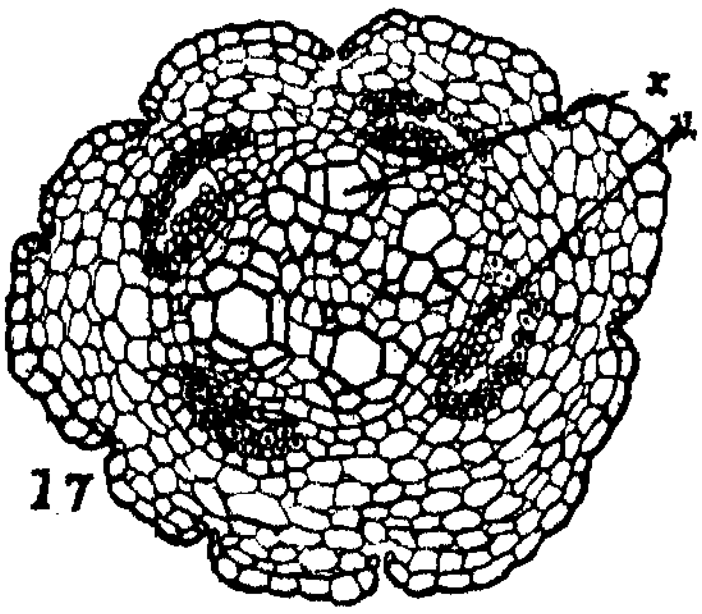
The coils may be loose in parts, but at other points the number of coils in a short distance may be considerable. This close coiling is correlated with the development of haustoria (Fig. 1).

Structure of Parasite's Stem.

The stem of *C. glabella* is circular in section, except where the coiling may be so tight upon the soft-barked host that compression of the bark takes place and the cortical tissues swell out over the parasite's stem; in such circumstances the stem is elliptical in outline. The epidermal layer is strongly cutinised, and interrupted by stomata arranged in longitudinal groups of three to seven. These are sunken, and each has a very pronounced cuticular ridge forming a distinctive outer cavity. The stomatal groups open into a relatively large air space, which communicates with the small intercellular spaces in the cortex. Each layer resumes its latent meristematic activity when the haustorial disc develops. The epidermis is devoid of chlorophyll, but its cells contain abundant protoplasm, and a conspicuous nucleus. There are no trichomes present in this species (Fig. 17).

Passing inwards we next come to the cortex, composed of three or four rows of thin-walled cells, with abundant protoplasm and numerous small chloroplasts. This tissue constitutes the photosynthetic tissue of the parasite, for the leaves are reduced to small scales, with little or no chlorophyll, protecting the buds. Amongst the chlorophyllous cells, large isolated cells, without chloroplasts but with considerable protoplasm and mucilaginous sap, occur. These are probably concerned with the conservation of water in the stem. Intercellular spaces occur in this tissue, which forms a ring around the central vascular system. There is no definite endodermis to be distinguished. A group of thick-walled cells is in association with the phloem. The vascular bundles are reduced and separated from one another by comparatively broad tracts of parenchyma. The xylem consists of a few, large, pitted vessels, very numerous xylem-parenchyma cells, wood fibres

and the endarch protoxylem vessels. The phloem is composed of thin-walled elements protected on the outer margin by groups of thick-walled cells (Figs. 17, 18). Sometimes a cavity separates these from the phloem. Between the xylem and phloem groups a narrow cambial zone occurs. There is a central small pith which, like the medullary rays and xylem parenchyma, frequently contains starch. Many of the cells of the pith are pitted.



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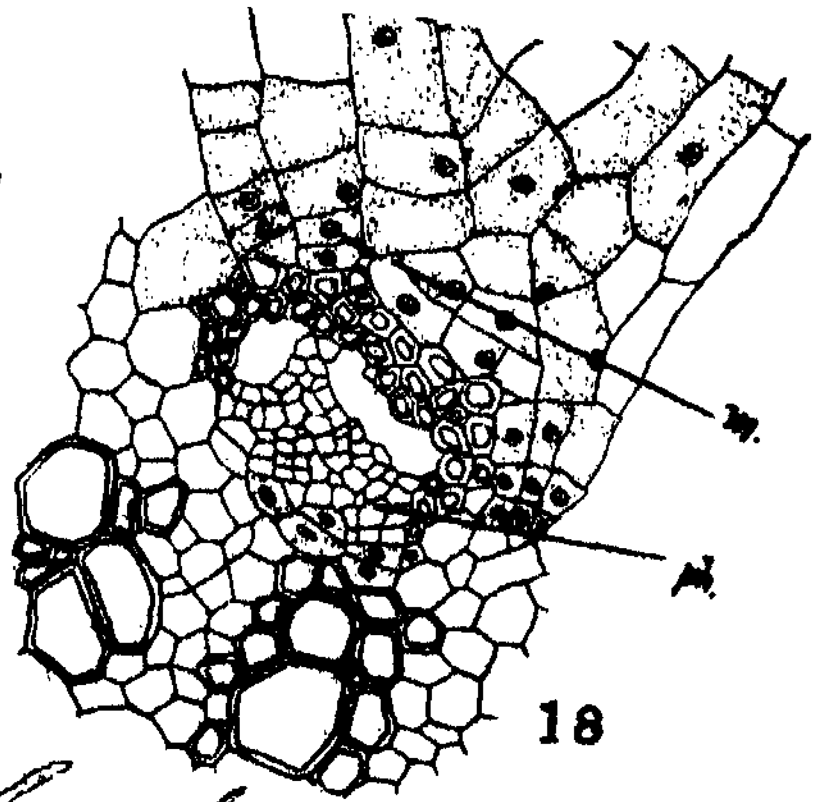

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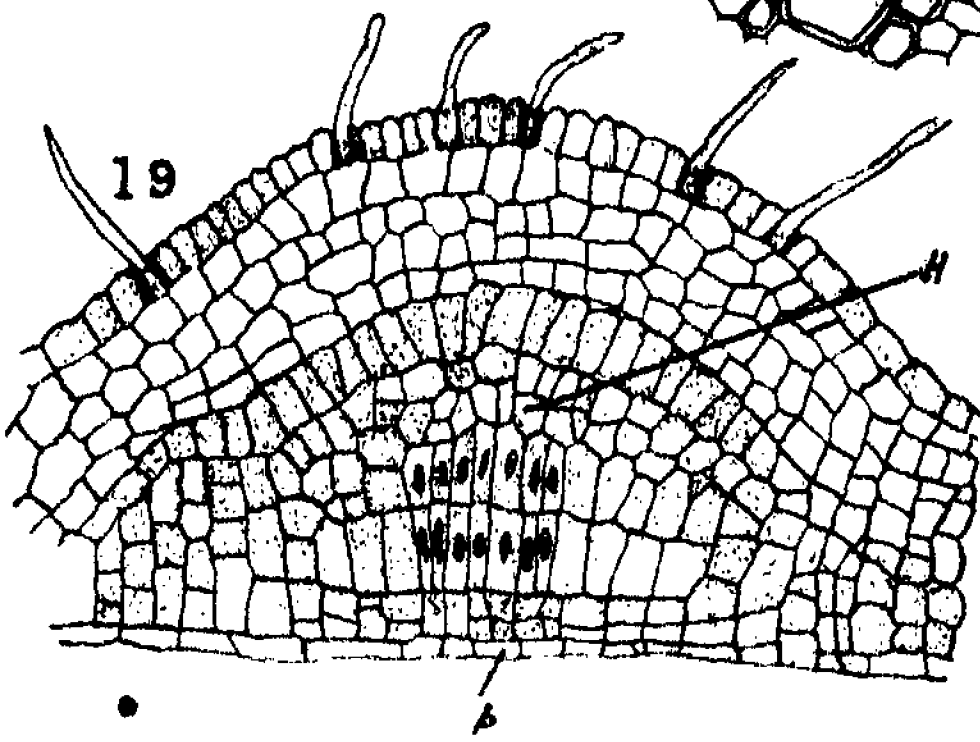


Fig. 17.—T. S. of stem of *C. glabella* showing its general structure; the xylem (x), phloem (ph), and fibres (f) are clearly delineated. (x 100.)

Fig. 18.—Portion of a T. S. of stem showing the vascular tissue and the cell-division (m), initiating the haustorium just outside the phloem (ph). (x 167.)

Fig. 19.—Part of a L. S. of stem of *C. pubescens* showing irregular surface contour, and the dermal hairs; also young haustorium (H.). (x 100.)

A radial section of the stem shows that the epidermal cells are oblong in outline; the hypodermis also consists of rectangular but wider cells; the chlorophyll-bearing cells have the same form as in the transverse section, while the elements of the vascular bundle are comparatively large pitted and smaller reticulated vessels, elongated thin-walled wood parenchyma, long narrow cambium cells, and thin-walled sieve tubes and companion cells. The tubes are shorter than one generally finds in Angiosperms, while their terminal walls are only slightly oblique. There is a thin but distinct callus over these walls.

The stems of *C. pubescens* are very similar to those of *C. glabella*, but hairs are very numerous in the former species. These arise from small, narrow, epi-

dermal cells, and are unicellular, with a cutinised tip and a central strand of granular protoplasm. The cuticle of the surrounding epidermal cells grows over the base of the hairs, so that it appears to dip into a narrow funnel. Each hair is in contact with a hypodermal cell, and has an aggregation of protoplasm at the base (Fig. 19). The older stems are characterised by a series of protuberances, imparting an irregular contour to the surface. *C. paniculata* and *C. glabella* are glabrous forms, resembling *C. melantha* closely in their anatomical features.

The Xerophily of Cassytha.

The governing factor in the construction of plants growing on physically or physiologically dry soils or as epiphytes and climbers is water conservation. When the plant is a water parasite and its hosts are xerophytes growing as a rule upon sandy soils which do not retain water tenaciously, the conservation of the available water is imperative. From the life conditions of the parasite it might be assumed that it would show many xerophilous features. Since the parasite is a chlorophyll-bearing form, its structure will represent a compromise between two fundamental principles of body construction, namely, the maximum development of chlorophyll-bearing surface, and minimum transpiratory surface. In *Cassytha,* therefore, the reduction of leaves from the main functional photosynthetic organs to mere scales protecting the young buds, and the relegation of the photosynthetic function to the stem is apparent. The photosynthetic tissue is very definite and comprises most of the cortical tissue. In addition to the reduction of leaf surface, there is a further xerophilous character indicated by the sunken position of the stomata, which are protected by a cuticular ridge developed over the guard cells and forming an outer chamber. The occurrence of considerable quantities of mucilage in cell walls and in cell cavities is a further indication of xerophily. The hairs of *C. pubescens* probably serve to reduce transpiratory activity as well as functioning as tactile organs. The root-system of xerophytes generally shows considerably greater development than that of hydrophytes, but in *Cassytha* it is reduced to very small proportions in the seedlings, and is absent entirely from the plant's economy in the later phases of its development. The reduced root-system is probably rather a derivative condition, owing to the assumption of a semi-parasitic mode of life by an originally xerophilous plant, than a primitive feature which has stimulated the adoption of parasitism to supplement its activity by securing supplies of water and solutes from plants supporting the parasite. All the species show a further xerophilous characteristic, namely, a very thick cuticle enveloping the outer layer of the epidermal wall.

External features and distribution of haustoria.

Haustoria of the species *C. pubescens* and *C. melantha* have the form of an elliptical disc, the periphery of which is generally raised and very closely applied to the host branch. The central zone of each disc is occupied by the actual sucker apparatus which grows into the host tissues. Between the central and peripheral parts there is a slight depression. The entire marginal portion of the haustorium is composed of parenchyma. Frequently the margin of the haustorium grows considerably and becomes firmly and closely applied to the surface of the branch. This region, as far as I have been able to find, never develops sucker-tissue, but its epidermal cells may be modified owing to contact with the support. It is merely a development to obtain, especially on villous stems and leaves or on leaves or stems with thick cuticles, a more secure attachment of the haustorial *disc* to the host, so that the pressure developed by the growing haustorium may

not push the host away. The haustoria are frequently circular, and sometimes of greater diameter than the stem of the parasite itself. No obvious difference in size between the parts of the parasite bearing haustoria, and those without, such as one might anticipate if much food were withdrawn from the host's tissues, was observed. There is normally a gradual tapering of the body from the base to apex, while, generally, long stretches of the parasite may have quite a uniform thickness. There are, however, occasional instances of considerable difference in size between haustorial and non-haustorial parts of the parasite, but these discrepancies are not due to the better nourishment of the haustorial regions as compared with those parts remote from haustoria, but rather to the lateral extension of the parasite itself owing to great pressure, to slight torsion of the stem, and to callus development on the host stimulated by the coils of the parasite. The parasite frequently compresses *Lasiopetalum* and *Hovea* stems so much that a distinct spiral groove is developed on the bark. The parasite, under such conditions, is generally elliptical in section. The host tissues sometimes develop over the region, leaving the climber more or less embedded in the tissues. In *C. glabella* and *C. paniculata* the haustoria may occasionally be so crowded that their margins are in contact. Where haustoria are numerous and have succeeded in penetrating the xylem of the host tissues, branches generally form. These do

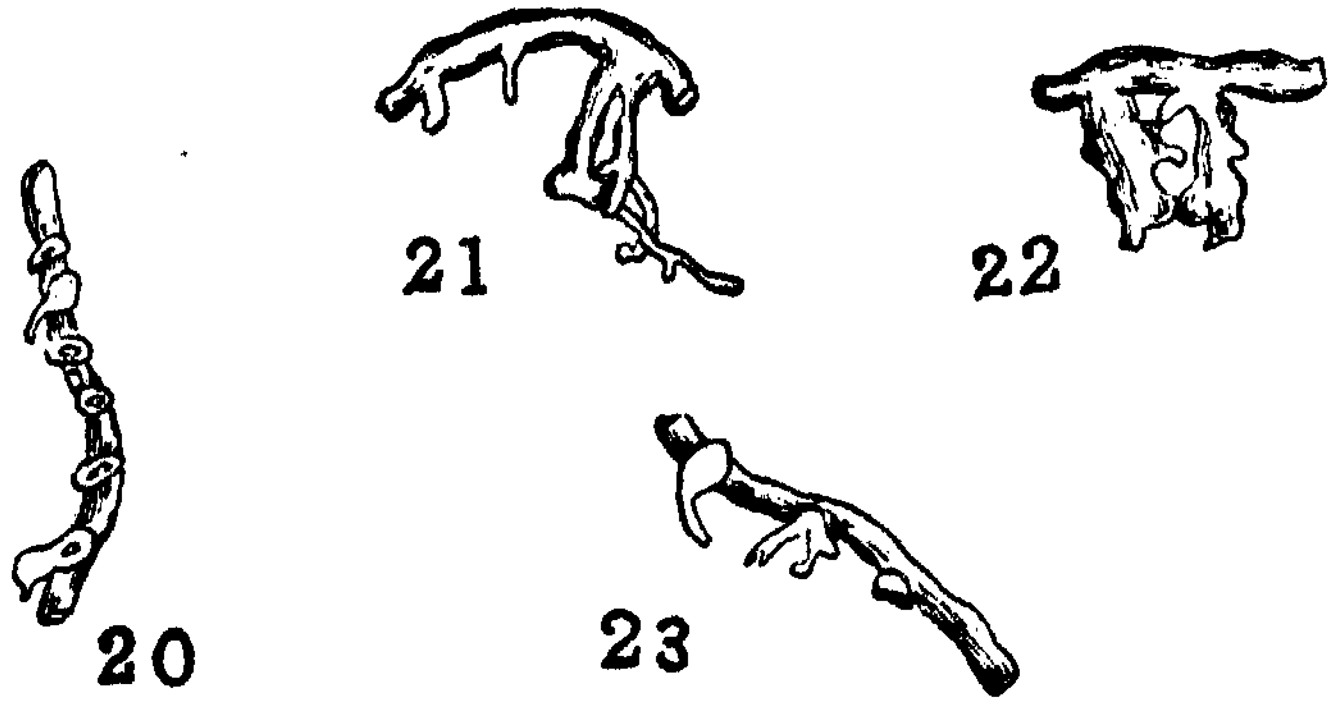


Fig. 20.—Haustoria of the parasite showing lateral developments of the cushion. (Nat. size.)

Figs. 21, 22, 23.—Haustoria of *C. paniculata* showing peculiar and irregular branching, which is a feature commonly observed in haustoria developing upon a yielding surface such as a leaf. (Nat. size.)

not appear until the coiling and haustorial development are complete. I have made careful study of this relation between the haustorial groups and the appearance and distribution of the parasite's branches, and there appears to be a definite connection between the penetration of the haustoria into the xylem of the host and the branching. Buds which have remained dormant during the coiling and formation of the haustoria, soon develop once this phase of the plant's activity is past.

A lateral growth from the periphery of the disc of some haustoria has been observed frequently. This growth may sometimes become lobed and invariably is closely attached to the surface of the host. This "proliferation" may be due to the tightening of the coils of the parasite upon the host and to torsion and

the consequent stimulation of the periphery of the haustorial disc by contact irritation. The result of this extension of the area stimulated would be the development of haustoria of greater surface and more firmly attached to the support (Fig. 20).

In *Cassytha melantha* and *C. pubescens*, branched haustoria are very common. These haustoria develop in the ordinary way, but the central cylinder of tissue bifurcates and branches several times on coming into close connection with the host. These occur almost invariably on coils of the parasite around soft leaves. When growing upon *Lasiopetalum*, the parasite develops numerous coils around the leaf, haustoria appear upon both surfaces, penetrating into the meso-

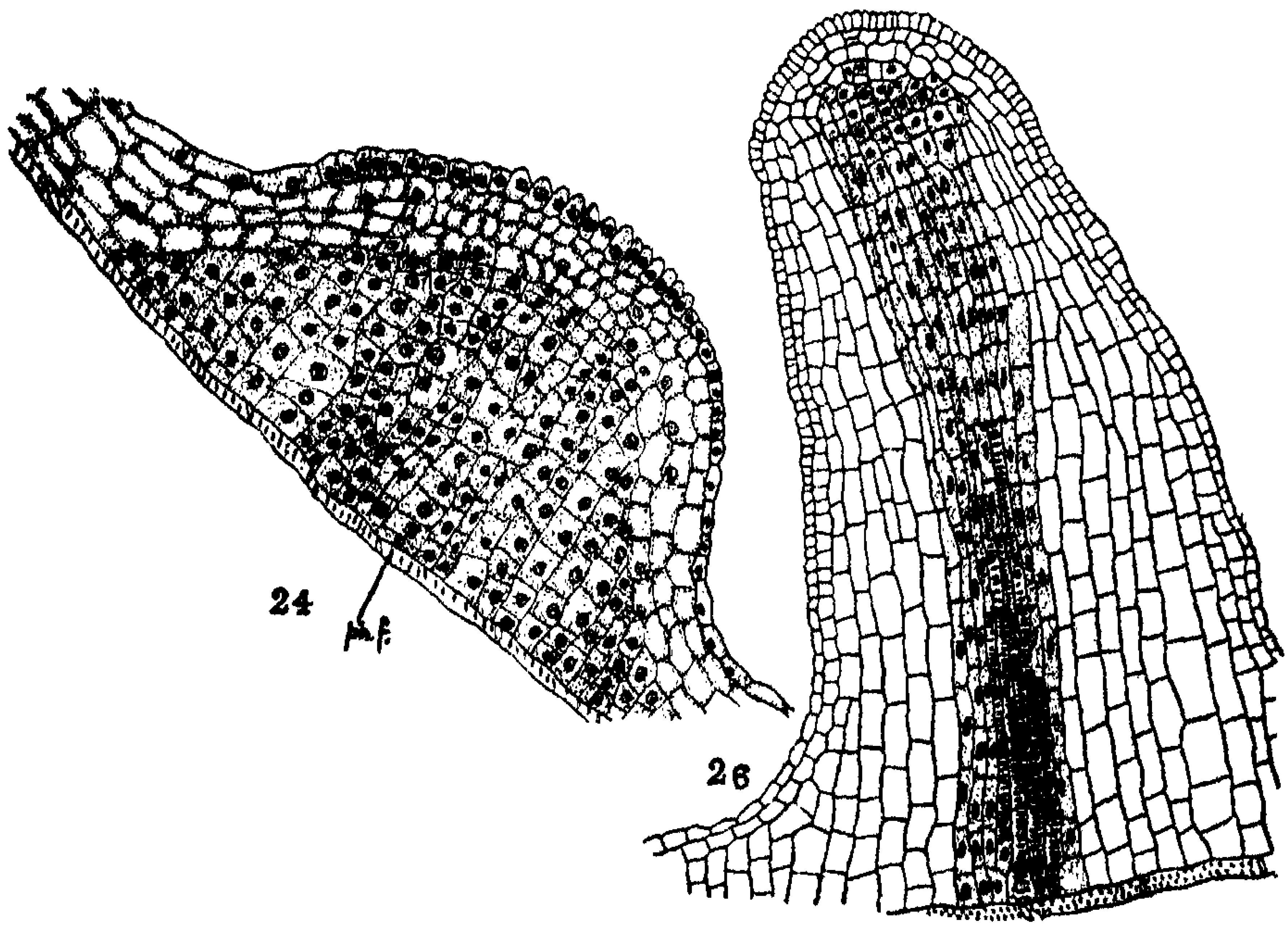


Fig. 24.—Longitudinal section of stem of parasite through a young haustorium embedded in the tissues. The rejuvenated epidermal cells of the stem are clearly indicated and the origin of the haustorium just outside the phloem fibres (ph.f.). (x 94.)

Fig. 26.—Longitudinal section of an abortive haustorium developing in contact with a yielding surface. The haustorial tissue has not broken through the overlying cortical and epidermal tissues of the stem which have kept pace with the development of the haustorium. (x 94.)

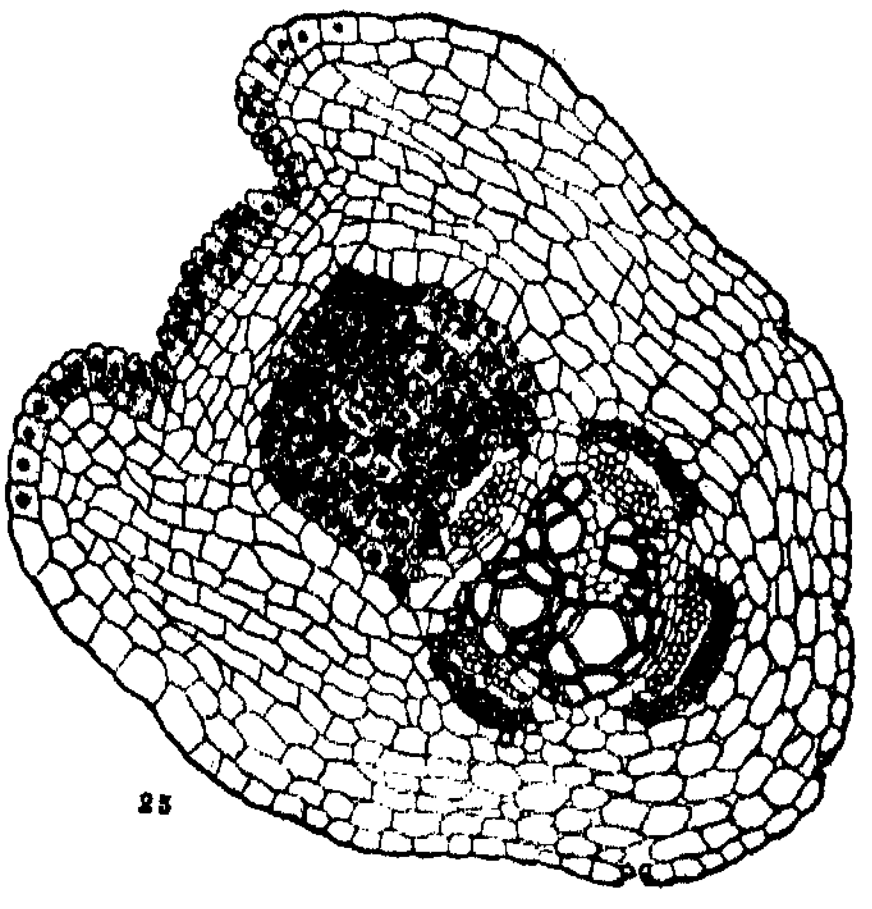
phyll cells. The pressure of the parasite causes the crushing and folding of the lamina, and in many instances the haustoria develop to an extent quite exceptional for any species of *Cassytha*. They branch like roots and grow over the surface and amongst the stellate hairs of the host, until some convolution of the lamina affords sufficient resistance to assist in penetration (Figs. 21-23).

Haustoria are developed only upon the close coils of the parasite in contact with stems, petioles or laminas of the host. In all the species I have examined, the long axis of the haustorium is generally approximately parallel to the axis of the host. Where the coils are close the divergence from the parallel position

is small; where the coils are long and loose the angle of divergence is greater. In this respect *Cassytha* resembles *Cuscuta*. Generally, the haustoria are raised.

The origin of the haustorium of C. glabella.

When the parasite has formed a series of close coils around a host branch, the concave surface of its stem is stimulated by contact and certain changes take place in the cortical zone. The cells from the pericycle outwards enlarge so as to produce a slight swelling upon the surface. A layer of cells just outside the phloem (possibly the pericycle) then begins active division, cutting off a series of cells by tangential divisions. The cells cut off in this manner at first form a flat discoid structure which gradually becomes more and more convex. This convex structure is clearly defined by the absence of chlorophyll from the cells, and by the very distinct, well delimited outer layer abutting upon the cortex. This



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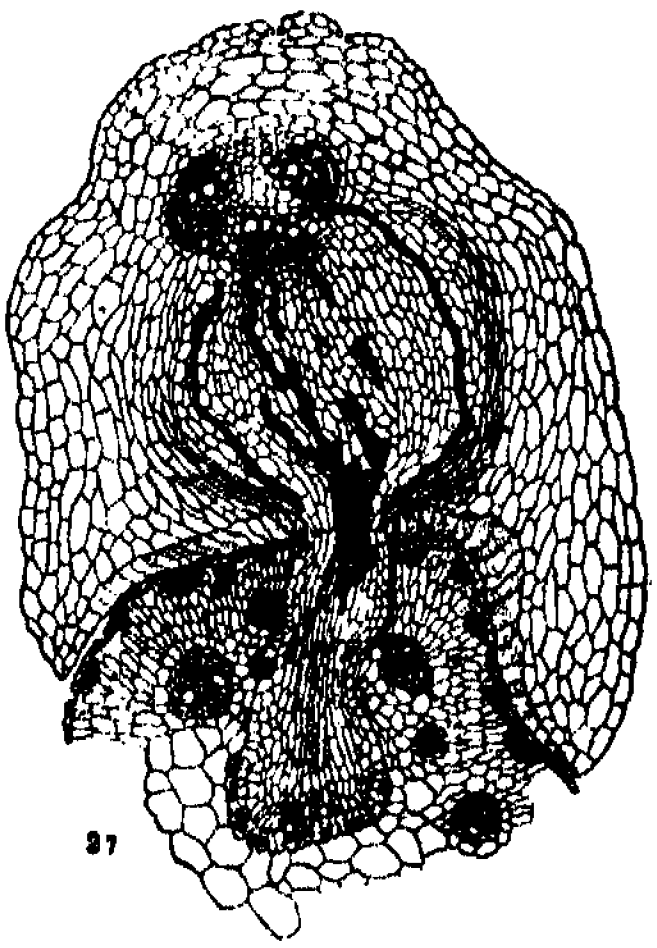

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Fig. 25.—T. S. of stem of parasite through a young haustorium embedded in its tissues. The origin of the haustorium just outside the phloem is indicated, and the transformation in the epidermis of the stem owing to contact with a support. The cortical tissues overlying the young haustorium show slight crushing. (x 83.)

Fig. 27.—L. S. of haustorium (T. S. through stem of parasite) showing the details of structure and the development of the sucker-apparatus into the leaf of *Xanthorrhoea* sp. The elongated cells at the tip of the haustorium are plainly seen. (x 50.)

body is the young sucker or haustorium. At this stage in its development the following parts may be distinguished: a superficial layer of cells with abundant protoplasmic contents and large nuclei and a small group of active meristematic cells just beneath; between this zone and the pericycle is a mass of elongated cells, whose elongation serves to increase the length of the haustorium (Figs. 18, 24, 25). These cells are of two types, namely, a central axial strand of narrow cells with protoplasmic contents and large nuclei, forming a procambial tissue; and a cortical zone of elongated, but wider cells with less protoplasm. The meristematic zone of the haustorium is responsible for the increase in its cells. As the haustorium grows, it pushes outwards upon the epidermis and cortical cells overlying it, and soon the swelling representing the haustorial disc increases in size. The epidermis of the stem and the tissues divide anticlinally to keep pace with the

growing haustorium, their activity may be maintained, as will be described later, for a very long time until haustoria attain a length of 5 to 10 mm. (Fig. 26). Generally, however, the haustorial disc is only slightly elevated beyond the general level of the stem, and, if contact with a host branch is continuous, the young haustorium soon develops through the overlying tissue. Where the contact irritation is intermittent, the growth of the haustorium is considerably slower, so that the outer tissues of the stem can keep pace with it.

Stimulation of contact then, induces the haustorium to form just outside the vascular cylinder, and at the same time the epidermal cells of the stem are rejuvenated, for, in addition to showing reawakened meristematic activity, they elongate considerably and become partially decutinised and densely protoplasmic. In short, they assume the typical form, appearance and structure of secretory cells (Figs. 24, 25). By their own elongation, the growth of the haustorial disc, and the tightening of the coils of the parasite upon the stem, they are brought into contact with, and finally adpressed to, the surface of the host. These elongated epidermal cells form the "cushion" of the disc and this may attain quite a considerable area. The epidermal cells in the centre of the cushion differ slightly in structure, in so far as they become papillate. Pierce has observed a similar papillate region in the "cushion" of the haustoria of *Cuscuta,* and has called it the "prehaustorium." The prehaustorium of *Cassytha* is not nearly so highly differentiated as appears to be the case in *Cuscuta;* but there is sufficient difference in structure to distinguish it from the ordinary cushion cells which merely serve to attain a close cementing of host and parasite together and to facilitate the development of pressure by the haustorium (Fig. 25).

In sections of slightly older haustoria, which have been in contact with a branch just long enough for the young haustorium to be ready to penetrate the host tissues, it will readily be seen that the sucker has become more conical, and that its apex has grown through the overlying tissues, pushing and crushing them in the process. Evidence of crushing may be seen along the sides of the haustorium. The overlying tissue is carried against the opposing host tissue and may be seen along the sides of the haustorium after penetration. As the epidermal cells of the haustorium emerge from the cortex, and are freed from the restraint of the overlying tissues, they become slightly papillate, while their thin walls, dense cell contents, and large nuclei suggest secretory activity (Fig. 30). In many cases, especially in the species *C. melantha* and *C. pubescens,* less frequently in *C. paniculata,* the cortical cells of the stem grow and divide by tangential walls so that when the growth of the young haustorium is slow, owing to the intermittent contact-irritation or to contact with a yielding surface, e.g., the lamina of a leaf, they may keep pace with its elongation. But this growth-phase of the cortex of the parasite stem forming the haustorial disc or cushion is particularly evident towards its periphery, so that its margin is slightly raised. The cushion accommodates itself to the contour of the support. This feature is not only apparent when the cushion is applied to cylindrical supports but when a haustorium is developed in contact with the leaf margin. In such cases the cushion margin grows considerably and curves, in order to grasp both the dorsal and ventral leaf surface. This characteristic, no doubt, may occur in *Cuscuta* in such circumstances, and seems to confirm the view suggested by Chatin in his description of *Cuscuta monogyna* that "the raised margin of the cushion acts as a prehensile organ." The "cushion" cells secrete a fluid which binds host and parasite together, while the central papillate cells prepare the path for the developing haustorium. There seems no doubt but that the most important factor in securing

penetration is the fluid secreted by these cells, as, no matter what torsions may take place in the cushion owing to the coiling of the stem, the young haustorium grows outwards through the overlying tissue towards the point of contact made by these papillate cells, so that, in some cases, the haustorium actually penetrates the host in an oblique direction. In such circumstances, it seems highly improbable that pressure could exert much influence in securing penetration. When the young haustorium penetrates the host, differentiation in the central zone of the shaft begins at its base, extending apically as the haustorium progresses into the host. Typical reticulate tracheids are formed from the central cells, and these are connected directly to the xylem of the mother stem (Fig. 27).

The Morphology of the Haustorium and its Parts.

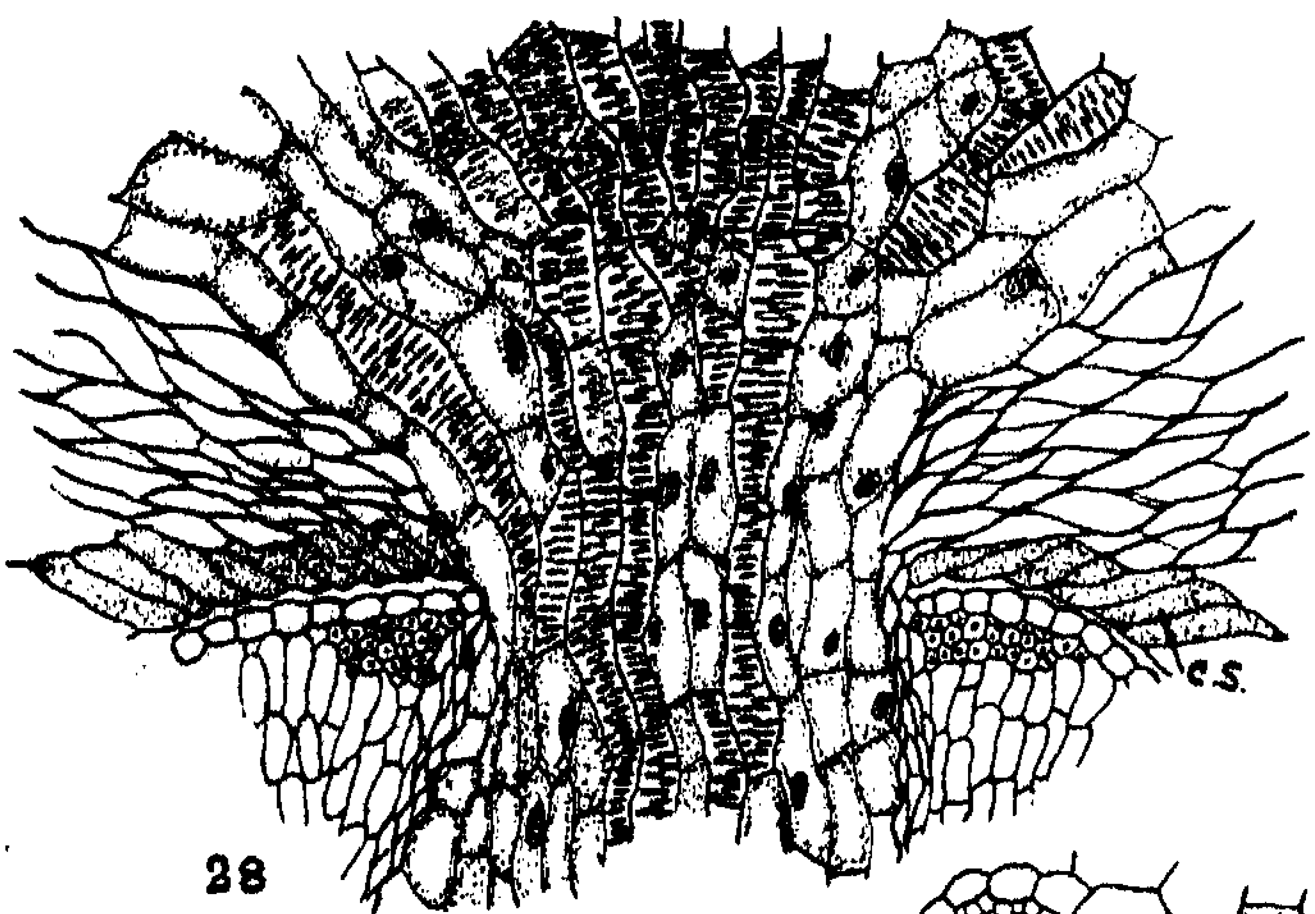
The haustorium of *Cassytha glabella* has precisely the same origin as that of *Cuscuta americana*: it arises in proximity to the phloem of a bundle. It is therefore endogenous, and, in point of origin, an adventitious root. Its structure, however, differs somewhat from that of *Cuscuta* and from a normal root. In the very young state, about the time the apex is ready to penetrate the tissue of the host, there are two or three groups of reticulate tracheids which, as the haustorium develops, become confluent forming a central axial core (Fig. 27) directly inserted upon the vessels of one or more bundles of the mother stem. Surrounding this central mass of tracheids, two or three layers of active procambial cells, which add to the tracheids as the haustorium develops, are formed. At the apex of the haustorium there is a well defined epidermis, characterised by its densely protoplasmic cell contents and the elongated form of the cells which become slightly papillate. There is no phloem in the haustorium, which never, at any stage of its development, shows the typical radial vascular structure of roots (Figs. 27, 28).

Morphologically, the haustorium of *Cassytha* is an adventitious root; its definite epidermis corresponds to the dermatogen of a normal root. There is no root-cap, although, physiologically, the overlying cortical and epidermal cells of the mother stem perform the function of such a structure until the haustorium actually penetrates the host. The cortical tissue of the haustorium appears to correspond to the periblem, while the central axial zone of the procambium cells and tracheids represents the plerome. The general relations of the epidermis, cortex and central cylinder of the haustorium, suggest the corresponding relations of dermatogen, periblem, and plerome of true roots. It, therefore, appears that the haustorium of *Cassytha* is a root whose structure is modified to meet a series of physiological conditions which are not presented to normal roots. Normal root-hairs are absent, but their function is to a certain extent performed by the papillate epidermal cells which undoubtedly possess greater solvent powers on account of their secretion. Pierce (1894) has given the term "sucker" to these cells, and considers them to be physiologically root-hairs which correspond in origin and position to the root-cap of ordinary roots. This appears to be the correct interpretation, and is equally applicable to the corresponding structures of *Cassytha glabella* and other species.

In *Cassytha glabella*, therefore, haustoria arise by contact of the parasite with the tissues of a host. Their origin is endogenous, while their structure is more simple than that of ordinary roots. They grow by a similar apical meristem. They are therefore adventitious roots whose structure is radically simplified, so that they may be more physiologically efficient amongst the tissues of the host.

Internal Structure of the Mature Haustorium.

The young haustorium of this species is composed of parenchymatous cells, containing conspicuous and relatively large nuclei, abundant granular protoplasm and food substances (Figs. 25, 27). This parenchymatous condition is evident in haustoria which have penetrated some distance into the cortex of the host. The foods which are particularly abundant in all young haustoria, even before they



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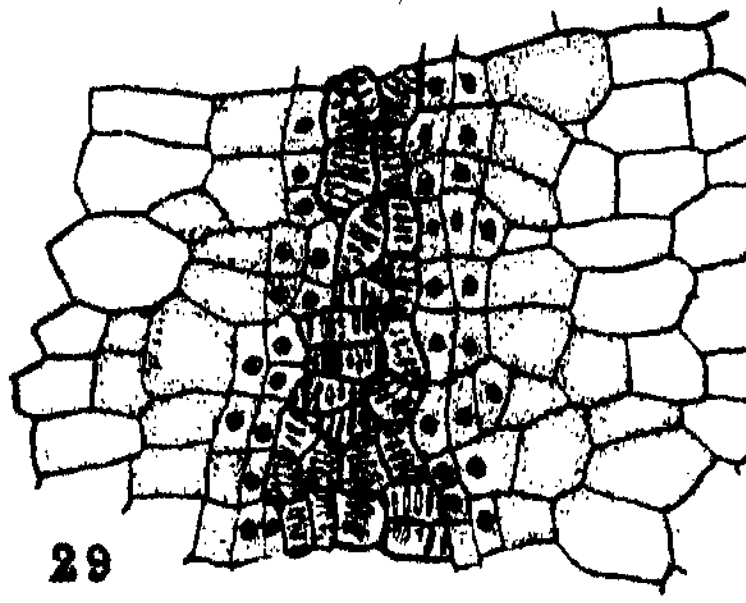

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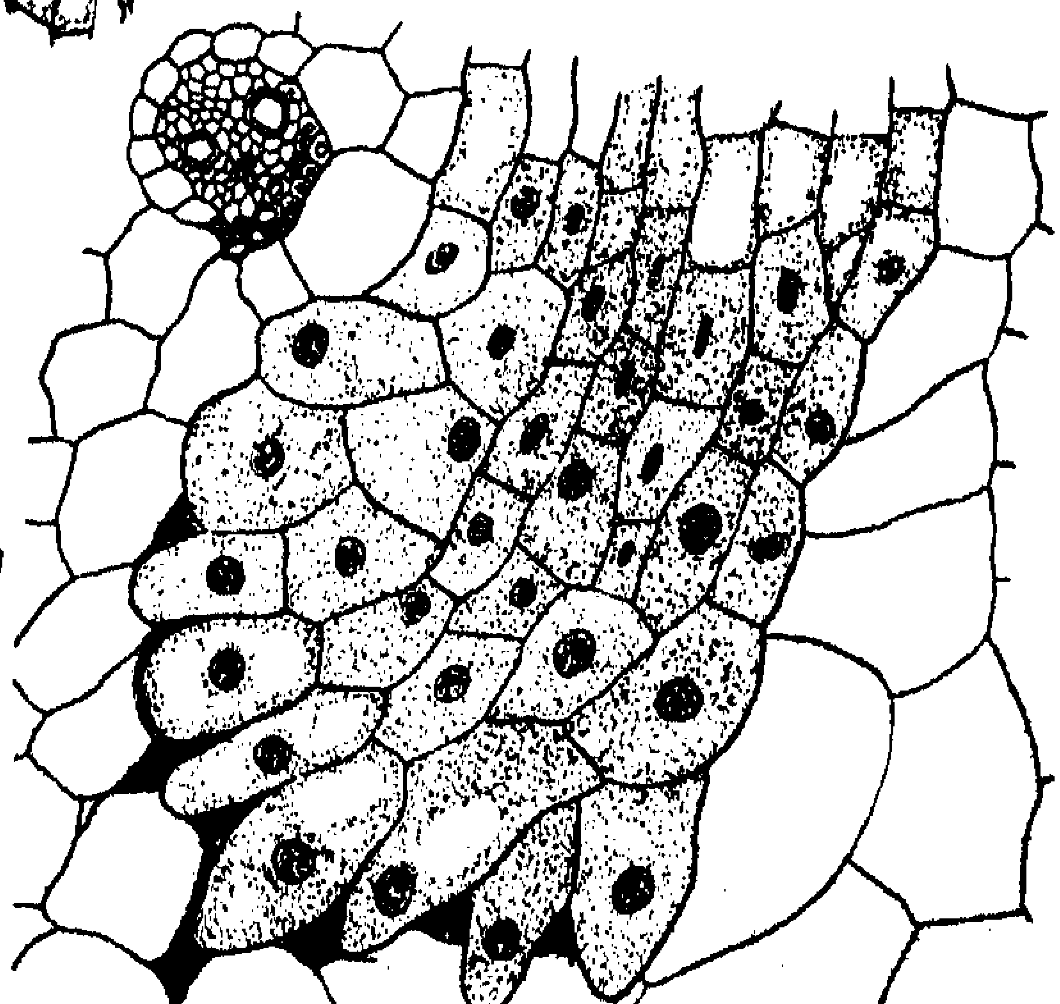

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Fig. 28.—Portion of a L. S. of a haustorium showing the cushion cells (c.s.), the crushed cells along the edge of the sucker and the tracheidal cells, bordered on each side by cambiform and cortical cells of the haustorium. No sieve tubes are present. (x 156))

Fig. 29.—T. S. of haustorium showing the tracheidal core, and the cambiform and cortical cells on each side. (x 156.)

Fig. 30.—Apex of the haustorium embedded in a leaf of *Xanthorrhoea* showing the papillate character of the peripheral cells. The shading in contact with the papillate cells indicates discoloration of the host's cells in advance of the sucker. (x 156.)

are in organic association with a host, are no doubt accumulated preparatory to their active growth. I have observed reserve starch in haustoria which are distinguishable by the small hemispherical or conical swelling upon the stem of the parasite. While such starch is accumulated by the parasite itself for the growth of the haustoria, it seems reasonable to assume that the solution of the walls and cell contents of the host by the penetrating haustoria, supplements these reserves.

In the mature haustorium, tracheids appear in three or four isolated groups which connect up to different bundles or to the same bundle at different levels of the main stem. There is generally a main group of tracheids in the centre and, on either side towards the base, one or more smaller groups. On each side of the tracheal groups, there is a zone of undifferentiated active procambium cells which add to the tracheal group and the cortex as the development of the haustorium demands. Surrounding this procambium tissue is a complete and comparatively narrow ring of wider cells forming the cortex of the haustorium, which abuts directly upon the cortical tissue of the main stem. There is no phloem developed, and therefore the vascular system of the haustorium is of the simplest type. The differentiation within the haustorium proceeds from the base towards the apex, and longitudinal sections of the haustorium show that the vascular tissue keeps pace in its development with the growth of the haustorium (Fig. 27). During the early growth of the haustorium, up to the time it becomes closely applied to the xylem tissues of the host, the water necessary for its rapid elongation is obtained directly from the parasite. As the haustorium penetrates more and more deeply into the host tissues, the tracheids become more numerous at its base. The tracheids have thick lignified and pitted walls. Their end-walls are only slightly oblique. The thickening is of the close reticulate character. Around this axial core of tracheids is a ring of procambium cells with long spindle-shaped nuclei which retain their meristematic character, and so increase the diameter of the haustorium (Fig. 29). Phloem tissue is absent; therefore, it appears that the haustoria of *Cassytha* are much more simple in their organisation than the corresponding structures of *Cuscuta*. Longitudinal sections of the haustoria were kept in an aqueous solution of aniline blue, others were stained with eosin and with Schultze's solution, but no indication of sieve tubes, callus plates, or anything resembling phloem tissue could be detected. *Cassytha*, therefore, is not a complete parasite like *Cuscuta*, but establishes organic connection with the xylem tissues only, and withdraws, from its numerous hosts, mainly water. If organic connection be established with the phloem of the host, one would anticipate the occurrence of sieve tubes in the haustorium or of sieve plates between the haustorial cells and the host phloem. The absence of such structures affords anatomical proof of the fact that *Cassytha* is only a water parasite and does not depend upon its host for the food necessary for its growth and flowering.

As the haustorium grows in length, following generally the radial path prepared by the solvent activity of its epidermal cells, the tracheids differentiate just behind the meristematic zone and keep pace in their development with the growth of the whole haustorium. In *Cassytha glabella* the diameter of the haustorium is small and uniform and the apex is irregularly rounded, owing to the different rate of growth of the epidermal papillae due to the variation in the resistance of the opposing tissues of the host. The margin of the haustorium embedded in the tissues of a host is delimited by a sheath of crushed dead cells (Fig. 28).

The elongated cells forming the papillate epidermis of the haustorium within the host tissues are densely protoplasmic and thin-walled. The nucleus is general-

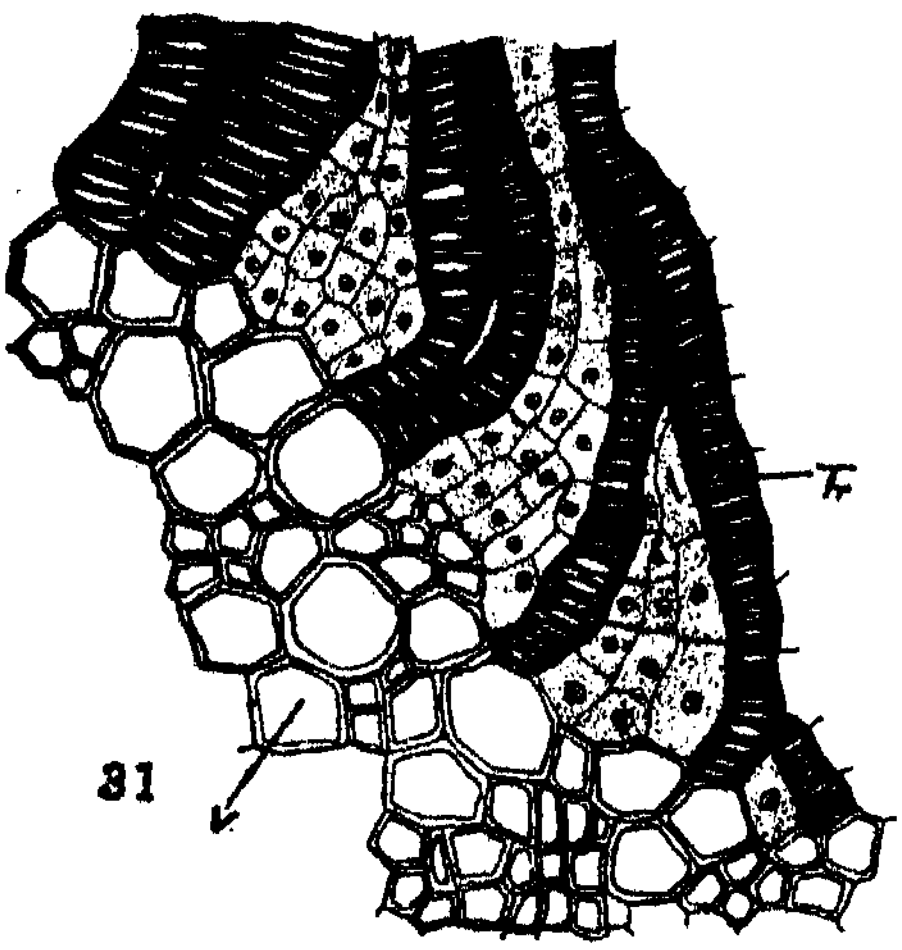
ly seen, as in most active secretory cells, near the tip of each cell. Where they develop through the intervascular or cortical parenchyma or through the phloem, their papillate structure is maintained (Fig. 30). They clear away the opposing tissue by the solvents. But, wherever they abut upon lignified tissue, their tips are almost invariably flattened (Fig. 31), and therefore swollen and almost globular in appearance. They only occur at the conical apex of the haustorium. The margin of the haustorium consists of ordinary cortical cells, which, however, as already mentioned, may retain their powers of meristematic and secretory activity.

The Haustorium of C. melantha.

The development and main structural features of the haustorium of this species are similar to *C. glabella*. Certain differences, however, are apparent and will be discussed.

The tip of the haustorium of *C. melantha* is more spreading than that of any other species, and the axial zone of tracheids, therefore, assumes a spreading, fan-like arrangement.

31



32

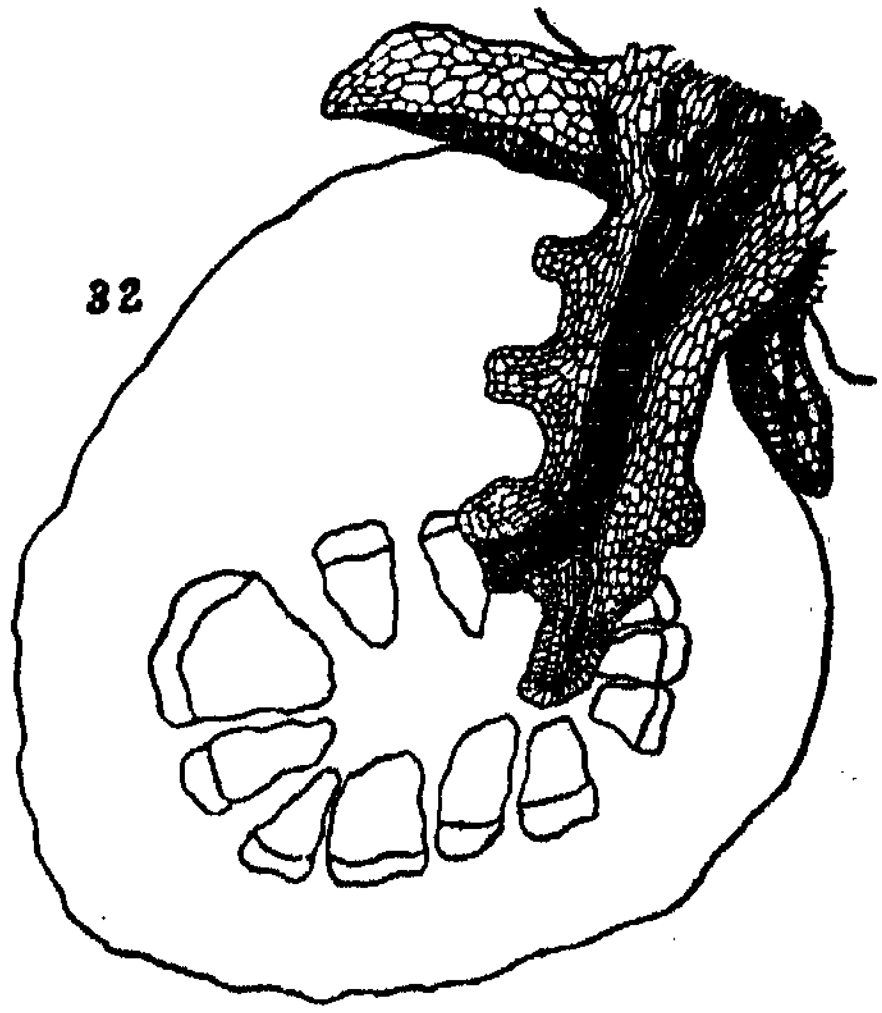


Fig. 31.—Portion of the apex of a haustorium embedded in the stem of the host, showing contact of the tracheids of the parasite (tr.) with the vessels of the host (v.). Many of the thin-walled peripheral cells of the haustorium are flattened against the lignified cells of the host. (x 156.)

Fig. 32.—L. S. of a haustorium of *C. melantha* embedded in a small stem of *Ficus* sp. and in contact with the vascular bundles of the host. In this section the marginal branching of the haustorium referred to in the text is shown. (x 94.)

In transverse sections of the stem of *Ficus* sp., passing through a haustorium of *C. melantha* embedded deeply in its tissues, it was observed that the haustorium traverses the cork which is dissolved by the solvents secreted by its tip, the cortical parenchyma, phloem, and enters the xylem. There is, therefore, a considerable destruction of host tissues along the path of penetration. The vascular bundles of *Ficus* sp. are of the ordinary endarch, collateral type, separated from one another by narrow medullary rays; while laticiferous tissue occurs in the

cortex and pith, and in association with the phloem. The haustorium penetrates deeply into the woody tissues and its apex, as well as its margins, is applied directly to the xylem elements. Growth of the meristematic cells behind the epidermal cells of the margin near the apex of the haustorium ceases, and they differentiate into tracheids. Cells of the haustorium immediately behind do likewise and so longitudinal rows of these tracheids are formed which are in direct communication with the xylem elements of the host and with the corresponding elements of the parasite stem (Fig. 31). The tip of the haustorium may continue to develop further into the xylem, generally following the medullary rays and occasionally the pith. I have not found the tip of the haustorium traversing the pith, although, I think, in *Cassytha* this may be expected. The reason that it does not occur is probably owing to self regulation on the part of the parasite, for the bundles on the opposite side of the pith to the haustorium will be tapped by haustoria higher up in the series of coils. A very noticeable characteristic of *Cassytha* is the development of haustoria in groups and the general correspondence in the number of haustoria to the vascular bundles of the host. This is not without exception, but, where an excess of haustoria does occur, the adverse effect is evident upon the host, and the parasite defeats its own ends. This probably explains the death of many young twigs and leaves of hosts attacked by the parasite. In the case of a *Sonchus* seedling forming the host of some of my experimental seedlings, there were only three vascular bundles in the petiole around which three complete coils of the parasite were formed. In these three coils, ten haustoria penetrating the bundles were formed. The leaf soon died, the conducting tissues of the petiole being unable to meet its demands and those of the parasite simultaneously.

A rather important feature of the haustoria of *C. melantha* is the marginal branching of the zone some distance behind the apex (Fig. 32). This suggests a retention of meristematic activity by cells of the cortex, and that the latter are also capable of secretory activity. I have found proliferous developments of the haustoria into the cortex of the host, growing obliquely through the cortex and phloem of the host and becoming applied to other bundles (cf. *Viscum album* and *Loranthus* spp.). The manner of growth of the haustorium on *Ficus* sp. suggests the application of its tracheids directly, not only upon the tangential walls of the water-conducting elements of the host, but frequently upon their radial walls. In transverse sections of the host through the haustorium, this method of application may be seen plainly where the destruction of a wedge-shaped mass of the xylem of the host takes place, e.g., in *Ficus*, *Lasiopetalum*, etc.

The application of the haustorial tracheids is to the radial walls generally, where the bundles of the host are isolated and the haustorium develops along the medullary rays. If radial longitudinal sections of the host be cut, passing through the haustoria, the first tangential application will also be demonstrated. In a longitudinal section of the mature haustorium upon *Ficus* the tracheids will be seen to curve towards the margin and to attach themselves to the radial walls.

The haustorium of *C. melantha* takes the form of a massive wedge with a broad base, and tapering or spreading apex.

SUMMARY.

1. The writer deals with the habit, habitat and parasitism of the several species of *Cassytha* found in New South Wales.
2. The plant is a twining parasite which forms alternating close and loose coils upon the stems, branches and leaves of the hosts.

3. The haustoria are confined to the series of close coils.
4. The development of the seedling is described, and the writer observed that the root-system functions longer than that of *Cuscuta*. The endosperm reserves are absorbed by the apex of the stem.
5. Growth is very rapid at first in the seedling, but ultimately is slowed down remarkably if contact with a support has not been secured.
6. The parasite develops considerable chlorophyll tissue in the cortex of the stem. In very exposed situations with strong insolation the parasite assumes a yellowish-green colour. The leaves are reduced to scales.
7. The parasite frequently develops upon its own branches, and shows no predilection for any particular host, provided its stem can twine round its branches.
8. The root-system of the seedling is reduced; the old plants have no direct soil relation.
9. Haustoria developing in contact with a yielding surface may attain considerable length before penetration, or may abort. Branched haustoria are common where the parasite is in contact with a yielding or pubescent surface.
10. The haustorium is a modified root, and has its inception immediately outside the phloem of the stem.
11. The epidermis of the parasitic stem is rejuvenated and divides while its cells become slightly papillate and form the haustorial "cushion" securing adhesion to the surface of the host branch or leaf.
12. No sieve tubes are present in the haustorium. This is a decided contrast to the haustorium of *Cuscuta* as described by Pierce.
13. The haustorium of *C. melantha* frequently develops lateral growths into the cortex or phloem of the host.
14. The parasite is highly xerophilous.

Botany School, University of Sydney, November, 1923.

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EXPLANATION OF PLATE XI.

General habit of *Cassytha*.—Photograph of *C. paniculata* growing upon several hosts, especially *Lasiopetalum ferrugineum* and *Banksia latifolia*.

THE *LORANTHACEAE* OF AUSTRALIA. Part v.

By W. F. Blakely, Botanical Assistant, National Herbarium, Sydney.

(Plates xvi.-xxvii.)

[Read 30th April, 1924.]

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20. Loranthus Nestor Moore. (Plate xvi.)

Journ. Bot., xxxv., 1897, 170.

Supplementary notes to the description.

The fruits are globose, densely woolly, 10-12 mm. long, but not seen in a fully developed state. Epicarp thick. Viscin not plentiful. Embryo very small for the size of the fruit, barely 1.5 mm. long.; embryonic cotyledons rather broad, spathulate when opened out. Primary leaves not seen.

Affinities.—*L. Nestor* is a very interesting species with a superficial resemblance to *L. Maideni* and *L. Quandang* Lindl., and would pass for these species when not in flower; the leaves are, however, more pubescent, and the young shoots rusty tomentose, eventually becoming quite glabrous with age. The flowers are large, and, when seen in the bud, are similar in shape to those of *L. gibberulus* Tate and *L. ferrugineiflorus* W. V. Fitz., though more closely resembling *L. gibberulus*, being densely covered with a soft woolly rufous tomentum, shaded purple in the upper part.

When not in flower it is similar to some of the short, broad-leaved forms of *L. vitellinus* F.v.M., especially in the venation of the leaves, which have distinctly raised nerves on the under surface.

Like *L. grandibracteus*, *L. Nestor* has outstanding characters which readily distinguish the two from all the other Australian species.

Range.—Between Kunnunoppin and Mt. Marshall; Comet Vale (on *Acacia quadrimarginea*); near type locality (near Bricke's Soak, between Goongarry and Mt. Margaret); Murrin Murrin, Austin district (George, in Herb. Berlin, *vide* Diels and Pritzel, Bot. Jahr., 35, 1905, 176. Dr. A. Morrison records it in "Notes Nat. Hist. W.A.," 1903, 204, and in W.A. Yearbook, 1904, without definite localities.

Hosts.—Leguminosae: *Acacia quadrimarginea* W. V. Fitz., *A.* sp.

21. LORANTHUS HILLIANA, n.sp. (Plate xvii.)

Frutex cinereus; foliis juvenilibus laneto-tomentosis, foliis adultis furfuraceis, oppositis, oblongi-lanceolatis, obtusis, crassis, 3—5-costatis, petiolatis, 4-7 cm. longis, 2½ cm. latis. Cymis axillaribus, 2-radiatis, radiis, utrisque flores tres sessiles gerentibus. Alabastis breviter lanati-tomentosis, clavatis, acutis, 20-23 mm. longis. Bracteis lateralibus cordatis, concavis, 2½ mm. longis; bractea intermedia lanceolata, 3 mm. longa, apice recurvato. Calyce subcylindracea truncata, 3-4 mm. Petalis 5-6, liberis, externe cinereis, interne viridis. Filamentis purpureis, 4 mm. longis; antheris adnatis, 2 mm. longis. Stylo filiforme quadrangulata; stigma parva, globosa. Fructo incognito.

Hoary plants, branchlets and young leaves minutely woolly-tomentose, adult leaves scurfy, opposite, narrow lanceolate to oblong, obtuse, obscurely 3—5-nerved, 4-7 cm. long, 2½ cm. broad; petioles about 1 cm. long. Inflorescence a two-branched axillary cyme; the common peduncle 10-14 mm. long; branches of the cyme shorter and thicker than the peduncle, bearing at the apex three almost sessile flowers. Buds closely woolly-tomentose, clavate, acute, 20-23 mm. long. Bract of the lateral flower cordate, concave, 2½ mm. long; bract of the central flower lanceolate, the apex abruptly deflexed, 3 mm. long. Calyx cylindrical to urceolate, minutely hoary-tomentose at the base, 4 mm. long; the limb entire, more or less carnose, 2 mm. long, pubescent on the margin. Petals 5 or 6, spathulate, acute, hoary on the outside, the inside greenish, minutely pubescent at the apex and along the commissural line. Filaments purple-brown, about 4 mm. long; anthers adnate, linear, pale purple, 2 mm. long, the cells very shallow. Style slender, quadrangular, thickened towards the base, bent towards the small globose stigma, pale purple throughout. Ripe fruit not seen, immature fruit urceolate, somewhat similar to the young fruit of *L. Maideni*.

Named in honour of the collector, Gerald F. Hill.

Affinities.—*L. Hilliana* has the two-branched cyme of *L. Nestor*, but the buds and bracts resemble those of *L. Maideni*, and were it not for the bifurcate cyme and longer leaves it would pass for that species. In the cyme and leaves *L. Hilliana* bears some resemblance to *L. Quandang;* the sessile flowers and different vestiture are the points which distinguish it from this species.

Range.—*Northern Territory*: 20 miles N.W. by N. of Meyer's Hill, McDonnell Ranges (G. F. Hill, No. 220, 1.6.1911). Recorded as *L. Quandang*, Ewart and Davies, Fl.N.T., 88. I have only seen one small specimen.

22. LORANTHUS LUCASI, n.sp. (Plate xviii.)

Syn.—*L. Quandang* Benth. (in part), *non* Lindley.

Frutex glaucus intomentosus ramis divaricatis crassioribus juvenilibus glabris nitentibus maturioribus lenticulatis. Folia opposita oblonga-lanceolata obtusa crassa glauca 3-5 costata. Petiolata 3-6 cm. longa, 1-5 cm. lata. Inflorescentia cymosa cymis axillaribus 2-4 radiata utroque radio 3 flores sessile ferente. Gemmae graciles clavatae 2 cm. Bracteae late-naviculares concavae acutae marginibus ciliatis. Calyx cupularis basi dense tomentosa. Corolla 3 petalis liberis viridibus necnon rubescentibus fragilibus nonnunquam basi unitis. Filamenta compressa straminea. Antherae adnatae angusti-lineares fragiles 2 mm. Fructus urceolatus vel ampulliformis 5-9 mm.

Glaucous shrubs, but not tomentose; branches divaricate, rather stout, slightly swollen at the nodes, the young ones smooth and shining, the old ones marked by numerous oblong lenticles. Leaves opposite, broad elliptical to oblong-lanceolate, obtuse, very rarely acute, thick, glaucous, triplinerved or quinquenerved, and often with prominent transverse veins on both surfaces, giving the leaf a wrinkled

appearance, abruptly narrowed into a short, distinct, somewhat compressed, straight or curved petiole, 3-6 cm. long, 1-5 cm. broad. Inflorescence cymose; cymes axillary, nearly as long as the leaves, glabrous, except the calyces; the common peduncle very slender, dark coloured, 2-3 cm. long, bearing 2-4 rays, each with 3 closely sessile flowers. Buds slender, 2 cm. long, clavate, somewhat inflated at the base. Bracts broadly navicular, concave, acute, with ciliate margins. Calyx cupular, densely woolly tomentose at the base, the limb rather large or about half the size of the calyx, glabrous, except for the almost entire, truncate, ciliate margin, 2 mm. long. Petals 5, free, green or reddish, occasionally shortly united at the base and falling off in pairs, narrow linear to linear spathulate, very thin and frail, recurved when fully developed, ciliate on the inner margins of the concave apex, somewhat rugose on the back. Filaments compressed, straw-coloured, adnate to the centre of the petals, 10-12 mm. long. Anthers adnate, narrow-linear, very frail, about 2 mm. long. Style slender, straw-coloured, sulcate; stigma minute. Fruit urceolate to flask-shaped, hoary tomentose, the limb dark coloured, contracted, closing over the thick 5-angled disc, 5-9 mm. long. Seeds obconic, with a sharp base, indistinctly 5-furrowed. Embryonic cotyledons obtuse, oblong-linear, 3 mm. long, but not seen in the ripe fruit.

Range.—So far *L. Lucasi* is confined to New South Wales and Queensland.

New South Wales: Near Darling River, E. of Broken Hill (on *Flindersia maculosa.* Leaves broad, green, somewhat like *L. miraculosa;* flowers yellowish-green; fruit small, white with a dark top); Grenfell; Nyngan (Cymes with 3 or 4 rays, each with 3 sessile yellowish or greenish flowers. Whole plant glabrous except the calyx. On *Flindersia maculosa* F.v.M., W. Bauerlen, No. 2477); West Bogan (on *Flindersia maculosa,* and *Grevillea striata*); Wittagoona, near Cobar; Yarrawin Station, Barwon River; Nulty-Toorale (on *Flindersia maculosa,* "Union ball-like without adventitious roots," J. L. Boorman); Narrabri; Walgett (on *Flindersia maculosa*); 40 or 50 miles North-west of Collarenebri (S. W. Jackson, No. 838, on *Atalantia glauca;* also No. 839, associated with *L. linearifolius, L. Mitchelliana* and parasitic on *Flindersia maculosa.* Nos. 838-839 constitute the type).

Queensland: Rosewood, 35 miles W.S.W. from Brisbane ("Flowers green or yellow; parasitic on a number of different kinds of trees principally *Melaleuca genistifolia,*" C. T. White, September, 1911; also recorded in Q'land Naturalist, 1911, as *L. Quandang*).

Affinities.—*L. Lucasi* is perhaps more closely allied to *L. obliqua* than to any other species. The leaves are, however, distinctly petiolate, and not sessile or oblique as those of its ally.

In the general colour of the leaves it resembles *L. Quandang,* but the flowers are all sessile, while only the central flowers are sessile in *L. Quandang.* There is a photograph of this plant in the "Forest Flora of New South Wales," vi., 282, as *L. Quandang.*

With *L. Benthami* it has a marked similarity in the buds and calyces, but the fruits are dissimilar, those of *L. Lucasi* being hoary carnose when ripe, of *L. Benthami* yellowish.

Named in honour of Mr. A. H. S. Lucas, M.A., B.Sc., late Headmaster, Sydney Grammar School, and honorary specialist for Algae, attached to the National Herbarium, Sydney.

Hosts.—Loranthaceae: *Loranthus Mitchelliana* Blakely. Proteaceae: *Grevillea*

striata R.Br. Rutaceae: *Flindersia maculosa* F.v.M., *Eremocitrus* (*Atalantia*) *glauca* Swingle. Myrtaceae: *Melaleuca genistifolia* Sm.

23. Loranthus Quandang (Lindl., MSS.). (Plate xix.)

Mitch. Three Exped., ii., 1838, 69; Hook., Mitch. Trop. Aust., 1848, 158, as *L. nutans* A. Cunn. MSS., *non* Sprengel; Walp., Repert. Bot. Syst., ii., 1851-52, 730, as *L. nutans* A.C.; Mueller, Trans. Vic. Inst., 228, as *L. canus*, also in Hook. Jour. Bot., viii., 1856, 144; Lindl., Ann. Sci. Nat., xv., 57; Benth., B.Fl., iii., 1866, 395 (in part).

The following is the original description:—

Loranthus Quandang (Lindl. MSS.); incanus, foliis oppositis lineari-oblongis obsoletè triplinerviis obtusis, pedunculis axillaribus folio multo brevioribus apice divaricato-bifidis 6-floris, floribus pentameris aequalibus, petalis linearibus, antheris linearibus basi insertis. Next *L. Gaudichaudi.*

The following is a more detailed description:—

Hoary or glaucous shrubs with more or less divaricate, erect or pendulous branches, 1-3 feet long, the young tips somewhat rusty tomentose, turning hoary with age. Leaves opposite or alternate on the same branch, narrow to broad lanceolate, or sometimes lanceolate falcate, 3—5-nerved, though usually 3-nerved, 5-10 cm. long, often somewhat rounded at the base, and ending in a well defined, usually terete petiole, 1-1.5 cm. long.

Inflorescence an axillary, two-branched, hoary, pubescent cyme, the common peduncle 1-2 cm. long, each branch bearing the flowers in triads, the central flower of each triad sessile, the lateral ones on short pedicels, rarely more than 2-3 mm. long. Bracts orbicular, concave, thick, ciliolate. Calyx hemispherical, with a small denticulate or ciliate expanded limb, scarcely exceeding 3 mm. in the newly expanded flower. Buds angular, contracted in the middle, swollen near the base, blending from purple white to lilac white (Plates 6 and 7 Dauthenay, Rep. de Coul.). Petals 5, straw yellow inside (Plate 31, *l.c.*), free to the base, densely clothed with white woolly hairs for about half their length, between the attachment of the free portion of the filaments and the apex. Filaments old carmine red (Plate 107, *l.c.*), the adnate portion ending in a spur-like callosity at the base.

Anthers about 3 mm. long, secund, narrow, linear, adnate. Style exceeding the anthers, green to creamy white at the base, shading into raspberry red at the top.

Fruit greenish-white, oblong-elliptical to urceolate, 5-7 mm. long, crowned with a somewhat conspicuous disc.

It has been recognised for a long time that the identity of this species was unsatisfactory, owing to the many forms attributed to it, and many botanists were at a loss to know what to regard as the typical form; this, perhaps, accounts for it not being figured, as it is as destructive to a certain class of vegetation as other species which have received considerable advertisement because of their noxious propensity. Indeed, the type specimen of *L. Quandang* in Lindley's herbarium at Cambridge is far from being satisfactory. According to Dr. Otto Stapf, in a letter to Mr. J. H. Maiden, Director, Botanic Gardens, Sydney, March 21st, 1919, "Lindley's sheet of *L. Quandang* contains two distinct species. One with the original label, "Scrub near Darling, 21st July, 1835," and another with a label with the general printed legend Major Mitchell's Expedition (1835). Now as to the two species on Lindley's sheet, the top one corresponds

to *L. pendulus* Sieb., var. *parviflorus* Benth., in "Fl. Aust." or at least to part of it, the bottom one (in fruit) to *L. nutans* A. Cunn. and *L. canus* F.v.M., which is in my opinion a synonym of *L. nutans*.

"Both are quoted in 'B.Fl.' under *L. Quandang*, but from an examination of our material, and Bentham's enumeration of specimens it is clear that he included under *L. Quandang* several, possibly as many as six, species."

As regards the two species on Lindley's type sheet referred to by Dr. Stapf, drawings of both were made by Miss Smith, the artist attached to Kew Herbarium, and presented to the National Herbarium, Sydney. The upper figure is labelled "Scrub near Darling, 21st July (1835), Flowers of the bush producing the round nuts." This is referable to *L. miraculosus* Miq. var. *Boormani*, *L. pendulus* var. *parviflorus* Bth. (in part). The lower figure is labelled "Interior of New Holland, Parasitical upon the *Quandang*, Major Mitchell's Expedition, 1835."

On looking up Mitchell's Three Expeditions, Vol. 1, 282, for 21st July, 1835, I find that Mitchell was on the Darling River, but no mention is made by him of a Loranth or a Quandang in his narrative. Turning to the original description (Vol. ii., p. 69), *L. Quandang* is connected with an observation recorded on May 9th, 1836, when Mitchell was on the Lachlan River between Lake Waljeers and Oxley, and the following reference to the plant is made by Mitchell. "I observed the Quandang bushes, having their branches covered with a parasitical plant, whose bright crimson flowers were very ornamental."

The discrepancy between the dates on the label and in the book I am not able to explain.

We must, therefore, accept the lower figure as representing the type of *L. Quandang* Lindl., as it agrees with the original description in all essential characters; the upper figure on the drawing of the type sheet is a glabrous plant, and is entirely different in flowers, fruit and arrangement of the cyme. Dr. Stapf is also of the same opinion, as he concludes, "The name Quandang if not dropped altogether should be connected with the bottom specimen on Lindley's type sheet."

The type appears from the drawing to have opposite and alternate leaves; they are narrow, lanceolate to somewhat broad-spathulate, obscurely 1—3-nerved, 1½-2½ inches long, tapering into a well defined petiole up to ½ inch long. Cymes short, two-branched, with 3-6 nearly sessile flowers. Fruit oval-oblong or somewhat urceolate, and usually with the style persistent upon it.

The term, "foliis oppositis," applied to the species in the original description, has influenced botanists to regard the opposite-leaved species, allied to *L. Quandang*, as being the same as it, hence the inclusion of so much variable material under this species. In the majority of cases the leaves of *L. Quandang* are alternate; to refer to them as being opposite or alternate would perhaps lead to fewer errors in the future.

It appears to me that Mitchell confused *L. miraculosus* Miq. with *L. Quandang*, by his reference to "the bright crimson flowers," as the flowers of the former are more highly coloured than those of the latter. He also appears to have mistaken the flowers of the Loranthus for those of the Quandang; hence his field note, "Flowers of the bush producing the round nuts," seems to be more applicable to the Quandang than to the Loranthus, and therefore does not apply to the lower specimen on Lindley's type sheet which, strangely enough, is in fruit, also in bud. The term "nut," would scarcely apply to the fruit of the Loranthus, at least not to the species involved, whereas it is commonly used to describe the fruits of the "Quandang," *Fusanus acuminatus* R.Br.

Bentham and Hooker (Genera Plantarum, iii., 208), ascribe the species *L. Quandang* to Mitchell instead of Lindley.

Synonyms.—*L. nutans* A. Cunn. et Hook., *L. pruinosus* A. Cunn., *L. canus* F.v.M., *L. pendulus* Sieb. var. *canus* Tate, *L. pendulus* Sieb. var. *canescens* Mueller and Tate.

Range.—The range of this species is very extensive; I have examined specimens, from all the States mentioned below, which are remarkable for their uniformity over such a large area. The peculiar two-branched cyme of this species impressed me as being a most stable character. Only once have I seen the cyme three-branched, and then, not on the typical form, but in the broad leaved form, or var. *Bancrofti*. The short hemispherical calyx is also a most constant character.

The species appears to be less common in Western Australia and the Northern Territory; this may be on account of the very imperfect botanical survey of those States.

Victoria: Mount Cole (J. W. Audas), Buffalo Creek (B.Fl.), Victorian Alps (Vict. Nat., xxvii., 1910, 112), Grampians (B.Fl.).

New South Wales: Moama; Cowabbies, Wagga District (on *Acacia Oswaldi*); Zara, Wanganella (on *A. pendula*), between Lake Waljeers and Oxley on the Lachlan (the type), Yenda (on *A. pendula*), Barmedman (on *Santalum acuminatum*), Fields Plains (on *Eucalyptus* and *Acacia*), Condobolin to Borambil, Parkes (on *Acacia pendula*), Lake Cargelligo, Eugowra (on *A. aneura*), Darling R. to Barrier Ranges, Broken Hill, between Bengala and Cassilis, Dandaloo (on *A. aneura*), Nevertire to Bourke (on species of *Acacia, Eucalyptus bicolor* and *Eremophila Mitchelli*), White Cliffs (on *A. cana*), Hunter River District, Warrumbungle Ranges, Boggabri (on *A. pendula*), Narrabri (on *A. pendula*), Burren Junction.

South Australia: Willochra Valley (Trans. Roy. Soc. S.A., vii., 1901), Cooper's Creek (B.Fl.), Adminga (Horn Exped. No. 1030 in Adelaide Herb.), Cootanoorina Creek, Arkaringa.

Queensland: Moreton Bay (B.Fl.), Bulloo River district (on *Atalaya hemiglauca*), Keppel Bay (R. Brown), near Jericho (on *Eucalyptus melanophloia*, Proc. Roy. Soc. N.S.W., xlix., 1915, 443), Thompson River (B.Fl.), Georgina River (E. W. Bick, in Queensland Herbarium), Sutton Desert (Mueller, B.Fl.), Cloncurry (R. H. Cambage, No. 3948), Boomaria (Proc. Roy. Soc. N.S.W., xlix., 1915, 429), Flinders and Mitchell Rivers (on the "Gidya," *Acacia Cambagei*; vide also Proc. Roy. Soc. N.S.W., iii., 107).

Northern Territory: Hermannsburg (Trans. Roy. Soc. S.A., v., (1881-82); Tate, Rept. Horn Exped., Part iii., 160), Stuart's Creek (B.Fl.), Victoria River (B.Fl.), Islands of the Gulf of Carpentaria (B.Fl.). These are probably referable to *L. conspicuus* Bail. or *L. congener* Sieb.

Western Australia: North of Kingoonya (Recorded in Trans. Roy. Geog. Soc. S.A., 1916-17, as *L. pendulus* Sieb. var. *canescens* Mueller and Tate. I take full responsibility for this name as I had followed Mueller before I had thoroughly investigated the synonyms of *L. Quandang Lindl.* [W.F.B.].

Affinities.—I could not understand why Lindley referred to *L. Gaudichaudi* DC., as having the closest affinity to *L. Quandang*, as the two are very dissimilar, until I saw the drawing of Lindley's type sheet of *L. Quandang* which contains (as already stated) two species. It at once occurred to me that he probably regarded the upper specimen as *L. Gaudichaudi*, a species that has been confused with *L. miraculosus* Miq., and the specimen on his type sheet appears to be re-

ferable to *L. miraculosus* Miq. var. *Boormani*, probably the closest affinity to *L. Quandang* in general appearance and in the sparsely flowered cyme, which character approaches more closely to *L. Quandang* than any other allied species. The leaves are also a good deal alike, but those of *L. Quandang* are usually broader, with more numerous veins, and are closely invested with a hoary pubescent vestiture, which serves as a sharp line of differentiation between them.

Perhaps *L. congener* Sieber is as closely allied to this species as the preceding, but the cyme is rarely, if ever, two-branched; the leaves are, however, somewhat similar, but those of *L. congener* are often broader and more shortly petiolate, and the veins are more obscure; as it is a coastal species, it is not likely to be mistaken for *L. Quandang*, which belongs more to the drier interior. Nevertheless, it was mistaken for the latter by Bentham and others, but this error will hardly be repeated, now that attention has been drawn to it.

It is very different from *L. pendulus* Sieber in foliage and inflorescence.

Hosts.—Santalaceae: *Santalum lanceolatum* R.Br. Leguminosae: *Acacia aneura* F.v.M., *A. cana* Maiden, *A. calamifolia* Sweet, *A. Cambagei* R. T. Baker, *A. homalophylla* A. Cunn., *A. melanoxylon* R.Br., *A. Oswaldi* F.v.M., *A. pendula* A. Cunn. Sapindaceae: *Atalaya hemiglauca* F.v.M. Myrtaceae: *Eucalyptus bicolor* A. Cunn., *E. crebra* F.v.M., *E. melanophloia* F.v.M. Myoporaceae: *Eremophila Mitchelli* Bth.

LORANTHUS QUANDANG, VAR. BANCROFTI Bail. (Plate xix., fig. 10.)

Q'land Agric. Journ., xxix., 1912, 180, plate 23; Bail., Comp. Cat. Q'land. Pl., fig. 448, p. 463.

The whole plant more or less puberulent. Leaves bluntly lanceolate, the base truncate, rounded, thin, tapering to a short petiole, 2-3½ in. long, ½-1¼ in. broad, coriaceous; longitudinal nerves 5, the three central ones more prominent than the others. Inflorescence much resembling other forms. Filaments and style of a rich purple. Eidsvold; Dr. T. L. Bancroft. This is probably the broad form referred to by Mitchell, Tropical Australia, pp. 158, 256.

Var. *Bancrofti* represents the coarse venulose quinque-nerved leaved form of the species, which appears to reach its greatest size in Queensland. It is also found over a large area in New South Wales.

Range.—*New South Wales*: 40 miles East of Broken Hill (on "Neelia," *Acacia Loderi*), Broken Hill (hosts: *Acacia aneura, A. Burkitti*, and *A. calamifolia*), Lake Cudgellico, Coolabah, Byrock (on *Acacia aneura*), Warren-Coonamble Road (on *Acacia pendula*), Gilgandra (on *Acacia pendula*, "Large masses infest the trees." R. H. Cambage, No. 1136; also recorded in Forest Flora of New South Wales, ii., 128, as *L. pendulus* Sieber, with a photograph by Mr. Cambage), Mount Terrible, Currabubula (on *Acacia neriifolia*, R. H. Cambage, No. 3777).

Queensland: Mt. Maria (in Queensland Herbarium. This locality is near the type locality of *L. nutans* A. Cunn. = *L. Quandang* Lindl.), near Mt. Mudge (Mitchell, August 1st, 1846), Eidsvold (only on 'Brigalow,' *Acacia harpophylla*, Dr. T. L. Bancroft), Nogoa River, Gindie, Aramac (The specimen has a seedling plant of *L. Exocarpi* attached to it [W.F.B.]), Longreach, Diamantina River (on *Acacia Cambagei*), Blackwater (on *Acacia harpophylla*).

Hosts.—Leguminosae: *Acacia aneura* F.v.M., *A. Burkitti* F.v.M., *A. calamifolia* Sweet, *A. Cambagei* Baker, *A. harpophylla* A. Cunn., *A. Loderi* Maiden, *A. neriifolia* A. Cunn., *A. pendula* A. Cunn.

24. LORANTHUS BENTHAMI, n.sp. (Plate xx.)

Frutex parvus confertus fusiformis ramis glabris necnon glaucis lenticulis obscuris. *Folia* glauca opposita cordata vel elliptica obtusa amplexicaulia 4 cm. longa 3 cm. lata imperfecta 3 vel 5 costata. Inflorescentia plerumque cymus bi-ramatus axillaris vel terminalis utroque ramo umbellano 3 florum quorum centralis sessilis ferente. Bracteae angustae ad late naviculares acutae. Calyx cupularis nec longus ad 3 mm. dentatus vel miniatus. Corolla 5 petalis liberis angusto-linearibus fragilissimis. Antherae adnatae oblongae 1½ mm. longae. Stylus sulcatus stigma vix augmenta. Fructus elliptico-oblongus vertice constrictus subtomentus superiore parte glabra, 10-12 mm. longus.

Small compact shrubs; union fusiform; branches rather stout, smooth, somewhat glaucous, otherwise glabrous, lenticles obscure or obsolete; leaves stem-clasping, rarely above 4 cm. long and 3 cm. broad, imperfectly 3—5-nerved. Inflorescence usually a 2-branched cyme, either axillary or terminal, each branch bearing an umbel of 3 flowers, the central one sessile, the lateral on very short or minute pedicels; common peduncle slender, terete, 10-15 mm. long, with an annular-like thickening at the top, and not bracteate as in most species; branches of the partial cyme 3-6 mm. long. Bracts narrow to broad, navicular, acute, strongly keeled, margins minutely ciliate with rufous hairs or glabrous, 1½ mm. long. Calyx cupular, under 3 mm. long, obscurely toothed or truncate, sometimes the limb ciliate, the base usually densely hoary tomentose. Buds slender, terete, rarely 2 cm. long, clavate, quite glabrous, pale pink in the lower half, greenish towards the top. Petals 5, free, narrow linear, concave and very fragile. Filaments free to about the centre of the petals, compressed, greenish; anthers adnate, oblong, 1½ mm. long, the cells conspicuous. Style minutely sulcate, geniculate a little below the scarcely enlarged stigma. Disc annular. Fruit elliptical-oblong, somewhat contracted at the top, semitomentose, or the upper half glabrous and dark coloured, the lower half yellowish, 10-12 mm. long, epicarp coriaceous. Seeds 6-8 mm. long, on a small spongy base; endosperm white, but as soon as germination takes place it turns green. Hypocotyl terete, verrucose; disc somewhat conical, papillose. The growth is exactly like that of *L. bifurcatus* and *L. congener*, but in appearance it resembles *L. grandibracteus*. The cotyledons are not withdrawn from the endosperm on germination.

Synonymous with *L. pendulus* Sieber, var. *amplexifolius* Benth. (B.Fl., iii., 394) and *L. Quandang* Lindl., var. *amplexifolius* Benth. (B.Fl., iii., p. 395).

A great deal of uncertainty centres around these varieties. The type of the former, according to the Director, Royal Botanic Gardens, Kew, is neither at Kew, nor at the British Museum. The latter was described by Bentham thus, "*L. Quandang* Lindl. var. ? *amplexifolius*. Leaves broad, sessile, cordate, Victoria River, F. Mueller; the specimen very imperfect and doubtful." I have seen a leaf of this specimen and find no difficulty in matching it with leaves of specimens collected by R. Helms, W. M. Cusack and J. T. Jutson. After a careful examination of material purporting to be either one or the other variety by different botanists, I fail to see any difference between them, and the justification of keeping them apart as varieties of either *L. pendulus* or *L. Quandang*, especially as the difference is so marked between those species. On the other hand, the large amount of variation admitted by Bentham under either species, afforded a convenient receptacle for quite a number of unknown species as shown in this monograph; and very naturally this particular form, which I propose to call *L. Benthami*, shows affinity to one of the plants included in Bentham's wide definition

of *L. pendulus* Sieb., and *L. Quandang* Lindl., namely *L. Lucasi*, which is dealt with above.

Range.—It is confined to North-west Australia: 40 miles south from Victoria Springs (on *Brachychiton Gregorii* F.v.M. Recorded by Mueller and Tate, Trans. Roy. Soc., S.A., xi., 1892, 360, as *L. pendulus* Sieb. var. *amplexifolius*. Through the kindness of Professor Osborn of the Adelaide Herbarium I was able to see this specimen, which is in the early fruiting stage. Leaves stem-clasping, cordate, oval-oblong, obtuse, faintly 3—5-nerved. Fruit oval-oblong, densely hoary at the base, crowned by a somewhat toothed calyx limb), Coolgardie (on *B. Gregorii*), Boulder, near Roan's Dam (on *B. Gregorii*), Comet Vale (on *B. Gregorii*, J. T. Jutson), Roebuck Bay (Leaves sessile, broad cordate, quoted by Bentham, as the type of *L. pendulus* Sieber var. *amplexifolius* Benth.), Cygnet Bay, West Kimberley (Leaves narrow to narrow-obovate 1½ inches long. Flowers yellow to green, scarcely ¾ in. long, on *Santalum lanceolatum* R.Br., W. V. Fitzgerald's MSS.), Sunday Island, between May and Meda Rivers (Leaves sessile, narrow oblong, 1-2½ inches long), Victoria River (quoted by Bentham as the type of *L. Quandang* Lindl. var. *amplexifolius*).

Affinities.—*L. Benthami* is very unlike the typical *L. pendulus* Sieber, and *L. Quandang* Lindl., and differs greatly from these species, not only in the shape and size of the leaves, but also in the structure of the flowers and cyme. Its nearest affinity appears to be with *L. obliqua;* they resemble each other a great deal in the structure of the common peduncle, and in the arrangement and outline of the closely packed triads of flowers.

L. Lucasi has more than a passing resemblance to this species, not only in the colour of the leaves, but more intimately in the shape of the buds and calyces.

The leaves of *L. Benthami* are somewhat analogous with those of *L. homoplasticus* and some species of *Eucalyptus*.

Hosts.—Santalaceae: *Santalum lanceolatum* R.Br. Sterculiaceae: *Brachychiton Gregorii* F.v.M., the common host plant.

(D) *Capitellati* Engler.

Capitellées van Tiegh. *l.c.*

Inflorescence capitate. Flowers 4-6, sessile on the summit of the peduncle, or the outer flowers on very short bracteate pedicels.

25. Loranthus Maideni, n.sp. (Plate xxi.)

L. Quandang Benth. and others (*non* Lindley).

Frutex confertus cinerens ramis divaricatis teretibus tomentosis. Folia opposita oblonga lanceolata vel elliptica obtusa petiolata. Inflorescentia pedunculo compresso capitato 3-6 sessilibus floribus. Gemmae cinereae teretes 2-2½ cm. Calyx sub-cylindraceus truncatus 3 mm. Corolla 5 petalis liberis externe cinereis interne rubescentibus. Filamenta flavescentia. Antherae adnatae 1-2 mm. Fructus urceolatus dense nisi superne cinereus.

Compact hoary shrubs with rather short, divaricate, terete tomentose branches. Leaves opposite, narrow oblong, spathulate to oblong lanceolate, obtuse or elliptical, gradually tapering into the petiole, almost glabrous when old, the very young ones mealy or scurfy, more or less of a dull yellowish or greyish-green colour, coriaceous, 3—5-nerved, or in some specimens the veins obscure, 3-5 cm. long.

Inflorescence an axillary or terminal compressed capitate peduncle, bearing

3-6 closely sessile flowers; the common peduncle erect or recurved, dilated upwards, 1.5-2 cm. long. Buds hoary, terete, somewhat clavate, slightly inflated at the base, straight or curved, 2-2½ cm. long. Outer bracts decurrent and persistent on the peduncle, narrow oblong, with a conspicuous, recurved, obtuse lobe, longer than the inner ones and quite different in shape; inner bracts deciduous or falling off with the calyces, erect, broadly and obliquely cordate, concave, hoary, more or less carnose, rarely exceeding the calyx.

Calyx semi-cylindrical, truncate, the limb rather large and darker or less tomentose than the base, 3 mm. long. Petals 5, linear-lanceolate, free, hoary outside, reddish inside, the inner margins minutely puberulent or irregularly barbed with erect, minute, deciduous bristles. Filaments free to about the centre of the petals, yellowish; anthers adnate, oblong, 1-2 mm. long.

Style yellowish, angular, somewhat flexuous, geniculate about 3 mm. below the small capitate stigma. Disc raised around the base of the style into 4-5 acute angles, surrounded alternately by a paler and darker zone.

Fruit urceolate, densely hoary, except the upper portion or neck, 6-8 mm. long. Epicarp thick, seeds elliptical, obscurely 5-ribbed, 3 mm. long, but only seen in a dried state. Embryonic cotyledons oblong, with a broad base, 2 mm. long, not withdrawn from the endosperm on germination. Hypocotyl minutely tuberculate with reddish tubercules.

Named in honour of Mr. J. H. Maiden, F.R.S., Government Botanist of New South Wales and Director, Botanic Gardens, Sydney, who for many years has taken a keen interest in the Loranthaceae.

Range.—This species is endemic to the dry interior of Western Australia, South Australia, New South Wales and Queensland. Its habit is still imperfectly known.

New South Wales: Narrabri, Tarcoon, Cobar, Paroo River, Paldrumatta Bore, Tarella, Broken Hill, near Thackaringa. On species of Acacia (*A. harpophylla, A. aneura, A. tetragonophylla*).

Queensland: N.S.W. border north and a little west of Broken Hill, Diamantina R.

South Australia: Mooloodoo Stn. between Beltana and Blinman (on *Myoporum platycarpum*), Youralanna Waterhole near Goddard Ranges, Mt. Lyndhurst (on *A. aneura* or *A. tetragonophylla*; recorded as *L. Quandang*, Trans. Roy. Soc. S.A., vi., 1883, 103), Tarcoola, Moorilyanna Native Well, Wanberlana (on *A. aneura*).

Western Australia: Victoria Desert (on *A. aneura;* recorded as *L. Quandang,* Trans. Roy. Soc. S.A., xvi., 1892, 360).

Affinities.—Its position is near *L. Fitzgeraldi,* on the one hand, and *L. Nestor* on the other. From the former it is distinguished by the larger and more compact cyme, sessile flowers, and larger bracts; from *L. Nestor* by the differently shaped leaves and venation, smaller flowers, closer vestiture, and smaller bracts.

Like its nearest ally, it has been mistaken for *L. Quandang* Lindl. on many occasions, but it is very dissimilar from that species in all essential characters, although, ecologically, they have much in common, sharing the same environmental conditions.

Hosts.—Leguminosae: *Acacia aneura* F.v.M., *A. harpophylla* A. Cunn., *A. tetragonophylla* F.v.M. Myoporaceae: *Myoporum platycarpum* R.Br.

Frutex ramis erectis minute tomentosis lenticularibus obscuris. Folia opposita juvenilia aureo-pubescentia vel paullatim ferruginea elliptica spathulata obtusa triplicostata in brevi petiolo constricta 2-3 cm. longa 1-3 cm. lata. Cymi

axillares singuli vel pares communi pedunculo superne dilatato rugoso 3-5 flores externos pedicellatos internos sessiles ferente. Bracteae rugosae cordatae. Gemmae tenues cylindricae cinereo-tomentosae 2 cm. longae. Calyx dense tomentosus angusti-cupularis 2 mm. longus. Corolla 5 petalis interne rufis externe cinereis. Filamenta compressa longiora antheris. Antherae adnatae lineari-oblongae crassae 2 mm. longae. Fructus urceolatus vel ellipticus tomentosus 6-7 mm. longus.

Plants hoary; mode of attachment unknown, branches apparently erect, minutely tomentose and lenticulate, dark coloured; leaves opposite, the young ones golden pubescent or slightly ferruginous at the tips, the older ones hoary, or lead coloured and almost glabrous, elliptical to spathulate, oblong, obtuse, triplinerved, narrowed into a distinct petiole, 2-3 cm. long, 1-2 cm. broad. Cymes axillary, single or in pairs, the common peduncle slender, terete, except towards the top, sulcate or rugose, tomentose, bearing 3-5 closely packed flowers, the outer ones on short, stout, articulate-bracteate pedicels, the inner, or central ones sessile, and often with a small bract. Bracts rugose, lead-coloured, gibbose, broadly cordate,

acute, nearly embracing the calyx and sometimes exceeding it, though usually about the same length. Buds slender, cylindrical, acute or slightly rostrate, hoary-tomentose, 2 cm. long. Calyx densely tomentose, narrow cupular, 2 mm. long. Petals 5, free, usually reddish inside, linear lanceolate, the basal portion linear; filaments compressed, narrowed upwards, varying in colour from yellowish to red, about twice as long as the anthers; anthers adnate, linear oblong, thick, 2 mm. long, the cells conspicuous. Style very slender, angular, abruptly bent beneath the small conical stigma. Disc angular, distinctly raised around the base of the style. Fruit urceolate to elliptic, tomentose, 6-7 mm. long, the calyx limb somewhat contracted, red when ripe (according to some collectors). Seeds elliptical, 4 mm. long, faintly 5-ribbed. Endosperm white; embryo 3 mm. long, slightly compressed, oblong; hypocotyl dark green, minutely verrucose.

Synonym.—*L. Quandang* Benth. (in part) (*non* Lindley).

Named in honour of Mr. W. V. Fitzgerald, author of the "Botany of the Kimberleys, North-west Australia."

Range.—Between Kunnunoppin and Mt. Marshall, 12 miles N.E. Kanowna (on *Acacia aneura*), Comet Vale (on *Acacia quadrimarginea* F.v.M. and *Acacia aneura* F.v.M., var. ?), Wilson's Creek between Wilson's pool and Lake Darlot (The host is a *Grevillea*, probably *G. aculeolata* S. Moore. Recorded as *L. Quandang*, Journ. Linn. Soc. London, xxxiv., 1898-1900, 226, but probably this species), Minginew (on *Acacia rostellifera* Bth.), Greenough (parasitic on "Raspberry Jam," *Acacia acuminata*), Irwin district (common on *Acacia acuminata*, sometimes on the same branch with *L. linophyllus*), Northampton, Murchison River.

Affinities.—*L. Fitzgeraldi* has been confused with *L. Quandang* Lindl., by many authors. Nearly all the Western Australian records of *L. Quandang* are referable to either *L. Maideni* or *L. Fitzgeraldi*. The flowers of *L. Fitzgeraldi* are very often in threes, but there never appear to be more than 5 in the cyme.

L. Fitzgeraldi differs from its nearest ally, *L. Maideni*, in the different structure of the cyme, totally different peduncle and bracts, more pointed buds and smaller stamens. The leaves are usually smaller with a more deciduous vestiture than that of *L. Maideni*. It is apparently a much smaller plant.

From *L. Lucasi* it is distinguished by its hoary vestiture and sub-composite cyme.

The short elliptic leaves, composite cyme and different shaped calyces are the characters which separate it from *L. Quandang* Lindl.

Hosts.—Proteaceae: *Grevillea aculeolata* S. Moore. Leguminosae: *Acacia acuminata* Benth., *A. aneura* F.v.M., *A. aneura* var., *A. quadrimarginea* F.v.M., *A. rostellifera* Benth.

Sect. DIPLATIA Engler.

Engl. et Prantl, Pflzfam. Nachtr., 1897, 129; genus *Diplatia* van Tiegh., Bull. Soc. bot. France, xli., 1894, 501.

Inflorescence capitate. Flowers 4-6, sessile on the dilated apex of the peduncle, between two large foliaceous bracts, with a very small deciduous, scarious bract at the base of the outer flowers. Petals 5. Calyx entire or toothed, usually minutely ciliate. Fruit urceolate, yellow. Viscin scanty. Large pendulous shrubs with a ball-like union, without adventitious roots. Leaves lanceolate or ligulate, 3–5-nerved.

27. LORANTHUS GRANDIBRACTEUS F.v.M. (Plates xxiii.)

Rept. Burdk. Exped., 1860, 14; Benth., B.Fl., iii., 1866, 395; Bail., Q'land Fl., v., 1381, Plate lxiv.; Van Tiegh., Bull. Soc. Bot. Fr., xli., 1894, 501, as *Diplatia*.

Additional notes to the description.

Glaucous plants forming fairly large masses. Union (according to Mr. J. L. Boorman) ball-like. Branches in the coastal plants rather short and stout; those of the interior long and slender, with numerous linear transverse lenticels, especially on the old branches. Pedicels axillary, fused into two foliaceous floral leaves, with the flowers between them in two closely sessile rows or clusters. Bracts attached to the fused pedicel or torus at the base of the calyx, and in some cases to the calyx, narrow-linear acute, slightly curved, about as long as the calyx, though sometimes longer; the central flower of each triad without bracts in all the flowers examined. Calyx cylindrical or shaped like a flower pot, 3-4 mm. long, the limb denticulate-ciliate, membranous, and the most deciduous of all the Australian species. Buds angular in the lower half, terete and slightly clavate, obtuse. Segments 5, cleft to the base; the petals, obtuse, deflexed, the basal portion much thicker than the free upper portion, caused by the fusion of the filaments. Filaments compressed, 2½ to 3 times as long as the anthers; the latter narrow, 3 mm. long. Style angular or sulcate, bent below the small capitate stigma. Disc pentagonal. Fruits elliptical, yellowish, smooth and shining, 10 to 12 mm. long, opening semi-apically. Viscin not very copious and not as sweet as in most species. Seeds oblong-elliptical, with a small spongy base, similar to *L. vitellinus* F.v.M.; endosperm green; hypocotyl green, terete, verrucose, very short. Cotyledons narrow linear, obtuse, 4 mm. long; suctoral disc white, conical and verrucose.

The plant figured by Bailey (*l.c.*) shows 3 spent flowers only, with the style exceeding the large foliaceous floral leaf, and is without any small floral bracts at the base of the calyx; these no doubt are deciduous at an early stage, as I have not seen them on any fruiting specimens, but on flowering ones only. The length of the foliaceous floral leaves varies; they are usually longer than the flowers in broad leaved specimens or those from coastal localities. In the case of the narrow-leaved forms, the floral leaves are usually shorter than the flowers. The Albert and Flinders River specimens collected by Mueller constitute the type;

these I have not seen. The above Rivers flow into the Gulf of Carpentaria at its most southern point in North Queensland.

Mueller (Report Burdk. Exped., 14) states that, "This curious plant attracted already Dr. Leichhardt's attention when passing on his discovery-journey over nearly the same tract of country where it was noticed by myself. Hence it is cursorily mentioned in the diary of that lamented traveller."

Affinities.—This species is distinct from all other Australian *Loranthus* in its large foliaceous floral leaves, which are confluent with the pedicel, and not articulate upon it; in this particular character it is only approached to a minor extent by *L. Nestor* S. Moore, which has conspicuous bracts, but they are quite distinct from those of *L. grandibracteus*. In *L. Murrayi* the pedicel is winged by the decurrent bract, which in some specimens is distinctly, though equally, bilobed, the longer sometimes exceeding the calyx and assuming a foliaceous appearance. If the development of both lobes were equal, we would then have, in a small way, a pair of foliaceous bracts as in *L. grandibracteus*. In the case of *L. Murrayi* the flowers are solitary, and the fact that the bracts are bilobed enables us to understand the origin of these bracts, which form an interesting natural link between these species. The foliage resembles in some cases that of *L. Miquelii*, and some of the small leaved forms of *L. sanguineus* F.v.M. The calyx more closely resembles the latter species than any other, but the buds and stigma are not the same.

At first I was inclined to regard *L. grandibracteus* as being so distinct from all the Australian *Loranthus* as to merit a different genus, but by the closer study of its most distinguishing character, in conjunction with those of *L. Nestor*, *L. Murrayi*, and to a limited extent, *L. linearifolius* (*L. Mitchelliana*), I have abandoned that view.

D. Oliver (Journ. Linn. Soc. Lond., vii., 101) refers to this species as *L. bracteatus* F.v.M., as does Mueller, *ibid.*, ix., 1857, 167.

Range.—This species extends from Thursday Island, N.W. of Cape York, the most northern point of the continent, to Cobar in New South Wales, its southern limit (*vide* F. E. Haviland, These Proceedings, xxxvi., 1911, 523) and extends to Western Australia, but I have no definite locality for it in the western State; it is included in Dr. Morrison's list of Extra-Tropical W.A. plants (Western Australian Year Book, 1900-01, 204). It is safe to assume that it will be found skirting the Great Victoria and Gibson Deserts in Western Australia, as well as coastal localities in the North.

This species like many others follows closely the water-courses of the interior, and its fruits form an important article of food for the few frugivorous birds frequenting those parts.

Hosts.—Myrtaceae: *Melaleuca leucadendron* L., *Callistemon viminalis* Cheel, *Eucalyptus bicolor* A. Cunn., *E. microtheca* F.v.M., *E. Normantonensis* Maiden and Cambage, *E. populifolia* Hook. Rubiaceae: *Canthium vacciniifolium* F.v.M.

Sect. NEOTREUBELLA Engl. (of *Elytranthe*).

Engler et Prantl, Pflzfam., Nachtr., 1897, 126; *Treubella* van Tiegh., Bull. Soc. bot. France, xli., 1894, 265, *non* Pierre.

Inflorescence glabrous, racemose, racems secund, many flowered. Flowers ternate, sessile on the apex of the very short secondary peduncles, each supported by a small subcordate sessile bract. Buds cylindrical, acute or nearly so. Petals 5 or 6, free or sometimes imperfectly united 1-2 mm. from the base. Filaments slightly longer than the acute anthers. Style terete or angular; stigma small.

Fruit ovoid to urceolate, greenish, or more often guttate with pale streaks. Ovary 1-celled. Embryo subulate with a rather large disc. Embryonic cotyledons probably withdrawn from the endosperm when germination takes place. Pendulous and divaricate shrubs with smooth lenticulate whitish branches. Union fusiform with adventitious roots. Leaves usually opposite to broad lanceolate or cordate, penninerved.

Engler (Nachtr. 126) transfers the species belonging to this section to Elytranthe Blume. Taking *E. albidus* Blume as Blume's type of Elytranthe which he figured (Fl. Javae, iii., tab. xxii.) it appears to me to differ very materially from the species belonging to the Section Neotreubella, and is readily separated from them by the sheathing or tubular bract which embraces the gamopetalous flowers, and also in the ovary being two or more celled.

In *L. Britteni* and its allies, each flower is seated within a single subcordate bract; the petals are also free or sometimes imperfectly united 1-2 mm. from the base; while the ovary is one-celled.

It is obvious that the natural position of the species belonging to Section Neotreubella, is under subgenus Euloranthus in proximity to Section Amyema, from which they differ in the inflorescence being racemose, instead of being simple or cymose.

The disposition of the individual flowers is similar to those of *L. Lucasi, L. Betchei, L. conspicuus,* and *L. obliqua,* i.e., in sessile triads, and each flower is subtended by a small subcordate sessile bract.

All the other Australian species of the Euloranthus series, with the exception of *L. Nestor,* have either terete, flat, triplinerved or quinquenerved leaves. While all the species belonging to Section Neotreubella have penninerved leaves, somewhat similar to those of *L. Nestor,* a species which is rather anomalous in the venation of its leaves, while all the other essential characters are obviously those of Section Amyema.

28. LORANTHUS BRITTENI, n.sp. (Plate xxiv.)

Ill. Bot. Cook's Voy., iii., 1905, p. 87, fig. 276, as *L. pendulus* Sieb. var.? Britt.

Additional notes to the description.

Glabrous branches long and slender, smooth, and pale coloured. Leaves opposite, distantly alternate on some specimens, narrow lanceolate, or falcate lanceolate, obtuse, or sometimes gradually tapering into a sharp point, and usually contracted at the base into a long curved petiole, 1-nerved with a few fine lateral nerves, or, when thick, the median nerve prominent, 5-20 cm. long, 5-10 mm. broad. Inflorescence racemose, the racems secund, and the flowers mostly deflexed.

Bracts broadly cordate, the central one persistent on the pedicel. Calyx cylindric, 3 mm. long, the rather prominent limb minutely denticulate. Buds slender cylindrical, acute, slightly inflated towards the base, the raised commensural lines giving it an angular appearance, 20-25 mm. long. Petals 5-6, free, or imperfectly connate at the base, dark reddish-brown in a dry state, the centre thickened by the confluent adnate portion of the filament, which causes the inflation of the bud; free portion of the filament about the same length as the anthers, which are linear lanceolate, acute, 2½ mm. long. Fruits not seen in a fully developed state.

Named in honour of James Britten, late Senior Assistant, Department of Botany, British Museum.

Range.—North Queensland, N.E. coast (A. Cunningham and R. Brown, quoted by Bentham, under *L. signatus* F.v.M.), Endeavour River (Banks and Solander. The type, collected along with *L. bifurcatus* Bth., during Cook's voyage in the Endeavour along the N.E. coast in 1770), Gilbert River (Mueller, 1855).

The following specimens are identical with the preceding; Georgetown (on *Melaleuca leucadendron* L. var. *saligna* = *M. saligna* Schau., as *L. longifolius* Hook. (?) *vide* Proc. Roy. Soc. N.S.W., xlix., 1915, 416), Stannary Hills.

Affinity.—This species bears a somewhat strong resemblance to *L. biangulatus* W. V. Fitz., in the narrow leaves and secund racems, with its brilliant scarlet flowers. The leaves, however, are narrower and longer than those of *L. biangulatus*, and also considerably longer and narrower than those of *L. signatus*.

Hosts.—Myrtaceae: *Melaleuca leucadendron* L. var. *saligna* Bail.

29. LORANTHUS SIGNATUS F.v.M. (Plate xxv.)

Rept. Burdk. Exped., 1860, p. 12, as *L. insularum* (*non* A. Gray); Benth., B.Fl., iii., 1866, 392; Bail., Synop. Q'land. Pl., 1883, p. 450; Bail., Q'land. Fl., v., 1902, 1379.—*Treubella* van Tiegh. (*non* Pierre), Bull. Soc. bot. France, xli., 1894, 265.—*Elytranthe signata* Engl., Nachtr., iii., 126.

Mueller's description includes *L. insularum* A. Gray and *L. celastroides* Sieb. and Bentham's description includes *L. Britteni* and *L. amplexans*, therefore I proceed to describe its more fully:—

Mode of attachment and size of the plant unknown. From herbarium specimens the branches appear to belong to erect divaricately branched shrubs; they are smooth and pale coloured, rather stout, angled or decurrent at the nodes, and much enlarged or swollen, lenticels obscure. Leaves glaucous, opposite, from ovate to oval-oblong, obtuse, narrowed into a short petiole, 2-4 in. long, thick, penninerved, the midvein prominent. Inflorescence racemose, 2-8 cm. long, the rachis thick, the secondary peduncles 5-10 mm. long, curved, each bearing 3 closely sessile glabrous flowers, supported by three rather spreading, cordate, acute bracts, with membranous margins, and keeled or thickened at the base, about half the length of the calyx. Calyx cylindric, 3 mm. long, the limb membranous and usually truncate. Buds slender, 2½ cm. long, angular and inflated towards the base, the tops slightly thickened and more terete, the apex acute. Petals usually 6, lanceolate-acute, cleft to within 2 mm. of the base, and much broader in the lower portion than at the point of attachment of the short filaments, opening from the centre upwards. Anthers adnate, narrow linear, contorted when dry. Style curved, angular and enlarged in the lower half. Stigma confluent, very small. Fruit elliptical, 10 mm. long, faintly variegated with pale streaks, contracted at the top, the membranous calyx limb forming a collar-like termination; disc somewhat raised and thickened. Cotyledons acute, slightly curved, probably articulate upon the hypocotyl. Primary leaves not seen.

Synonyms.—*Loranthus insularum* F.v.M. (*non* A. Gray); *Treubella signata* (F.v.M.) van Tiegh.; *Elytranthe signata* (F. Muell) Engler.

Range.—The species is a tropical one, and is not recorded further south than Kimberley district, Western Australia. The type came from the Gilbert River (*vide* Mueller's Report Burdekin Expedition, under *L. insularum*). One of Mueller's specimens in Melbourne Herb., agreeing with the type, is without locality, but the date is September, 1855, which coincides with the date of Flood's specimen of *L. amplexans*. The localities recorded by Bentham (B.Fl.) are Arnhem's Bay, and Islands of the Gulf of Carpentaria. R. Brown; North Coast, Mueller. These specimens I have not seen, and as they are not commented upon

by Bentham, I assume that they belong to the typical form. It has since been collected at Castlereagh Bay, Arnhem's Land (B. Gulliver, 1.2.1867).

Affinities.—Its nearest affinity is with *L. biangulatus* W. V. Fitz. which it very closely resembles in the colour and venation of the leaves, and to some extent in the secund inflorescence.

The characters which separate it from *L. Britteni* are its shorter and broader leaves and paler flowers.

To *L. vitellinus* F.v.M. it is allied in the shape and venation of the leaves, particularly the short broad lanceolate-leaved form so common in the Port Jackson district, and extending northwards along the coast.

Host.—Leguminosae: *Bauhinia* sp.

30. Loranthus amplexans (van Tiegh.). (Plate xxvi.)

Bull. Soc. bot. France, xli., 1894, 265.

I have not seen van Tieghem's description. In fact I am doubtful whether he described it, as I am informed that he did not describe his species, but used the name only. He probably received the specimen from Mueller as *L. signatus* F.v.M. var. *amplexans*.

Frutex ramis glabris robustis divaricatis; foliis glaucis, oppositis, latis ovato-lanceolatis, basi cordatis vel amplexis, coriaceis, 5-15 cm. longis, 3-5 cm. latis; inflorescentia racemosa, ramis secundis; floribus sessilibus ternatis; gemmis gracilibus, 20-25 mm.; calyce cupulare, 3 mm. longa; bracteis paris, cordatis; petalis 5-6, liberis, nonnumquam basi conjunctis; antheris linearibus; fructu ovato, fusco viride lineis inaequalibus vittato.

Glabrous, branches stout, divaricate, swollen at the nodes and somewhat prominently lenticulate with small orbicular lenticels. Leaves thin, rather large, opposite, sessile, with a cordate or amplexicaul base, broadly lanceolate and gradually tapering into the apex, but not acute, prominently, but distantly penninerved, the midvein conspicuous on both surfaces and sometimes showing the confluent secondary nerves, which, after following the midvein closely, diverge towards the margin, 3-6 inches long, 1½-2½ in. broad.

Inflorescence racemose, the flowers ternately arranged on the apex of the bracteate peduncles. Bracts cordate or orbicular, about 2 mm. long, the fused or persistent bract more acute than the two deciduous ones, not, or scarcely enlarging under the fruit. Calyx cupular, 3 mm. long, dark brown streaked with green stripes, the limb conspicuous, paler than the base of the calyx and usually truncate. Buds slender, slightly clavate, striate, or somewhat angular, straight or curved, reddish at the base, and shading into green towards the top, 24-27 mm. long. Petals usually 6, free, or sometimes partly united at the base into a small tube, 2-3 mm. long, narrow at the top, gradually broader towards the base. Filaments shorter than the anthers, the adnate portion somewhat raised on the inner surface of the petals, the very short free portion compressed, terminating a linear lanceolate anther, 3 mm. long. Style slender, gradually thickening towards the base and resting on a very small slightly raised disc. Fruit ovoid, dark green, striped with a lighter green, crowned with the persistent calyx limb, 5-7 mm. long, but not seen in a fully developed state. Embryo somewhat subulate, the cotyledons apparently articulate on the hypocotyl and probably withdrawn from the endosperm on germination. Suctoral disc broad.

Synonyms.—*L. signatus* F.v.M. var. *amplexans* (Herb.) Mueller.—*Treubella amplexans* van Tiegh., Bull. Soc. bot. France, xlii., 1895, 87.

Range.—The type is from Quail Island (Flood, 9.1855) quoted by Bentham. There are specimens in Herb. Melb. labelled *L. signatus* F.v.M. var. *amplexans* in Mueller's handwriting, but it was never published by him. This is probably the specimen referred to by Mueller in Hooker's Journ. Bot., viii., 1855, p. 50 ("Among the plants obtained (Quail Island) was a beautiful broad leaved *Loranthus*). There are two specimens from Quail Island; one with shorter leaves led Mueller to think that it was *L. insularum* A. Gray, and he suppressed his own species on that account. This, no doubt, is the *L. insularum* A. Gray, referred to in his Catalogue of the Plants of the Gulf of Carpentaria ("Appendix to Landsborough's Exploration of Australia, Carpentaria to Melbourne," 116). A specimen from near Darwin (Gilruth and Spencer, No. 655, July-August, 1911) is identical with the large specimen from Quail Island, and I have used it in drawing up this description. It is recorded as *L. signatus* F.v.M., by Ewart and Davies (Flora Northern Territory, p. 88. Common about Darwin).

Alice River (K. Sv. Vet. Akad., Handl., 52, 1916, p. 15, as *L. longifolius* var. *amplexifolius*).

Affinities.—Differing from *L. signatus* mainly in the stouter branches, larger, sessile or stem-clasping leaves, and in the longer raceme.

In the leaves it is allied to *L. dictyophlebus*, both in texture and shape, but they are strictly stem-clasping, paler, and the veins less reticulate.

Hosts.—Not mentioned.

31. LORANTHUS BIANGULATUS W. V. Fitz. (Plate xxvii.)

Proc. Roy. Soc. W.A., iii., 1916-1917, 35.

Pendulous, quite glabrous and somewhat glaucous, the internodes acutely two-angled or narrowly winged, widened upwards. Leaves opposite or subopposite, narrow to broad lanceolate, obtuse, tapering to the bases, mostly vertical, the veins numerous, very oblique and reticulate between; inflorescence an axillary, rarely terminal, distinctly pedunculate, raceme of usually five branches, each branch with three terminal closely sessile flowers; buds slender; bract as large as the adnate portion of the calyx; limb of calyx rather broad, membranous, obscurely toothed, and half as long as the tubes; corolla segments usually six, very narrow; anthers linear, adnate, much longer than the perianth segments; style slender, the stigma not broad; fruit ovoid, brownish. Leaves 4 in. long or less. Corolla segments $\frac{3}{4}$ in. long, pale yellow to red in the lower half, green in the upper portion. Anthers green or greenish-yellow. Fruit about 4 lines long. Type locality, base of Mount Broome. Parasitic on *Tristania suaveolens*, *Eugenia eucalyptoides*, W. V. Fitzgerald, No. 816, 5, 1905. Other localities are Sprigg, Isdell and Calder Rivers, W. V. Fitzgerald.

So far it is only recorded for Western Australia.

Affinities.—Its nearest affinity is with *L. Britteni*, to which it bears a general resemblance, both in the foliage and inflorescence, but the compressed winged branches readily separate it from that species.

To *L. vitellinus* F.v.M. it bears some resemblance in the shape, colour, and venation of the leaves. To *L. acacioides* A. Cunn. it is allied in foliage and glaucousness; but in floral characters it is quite different from both, being in another section.

The name was first published by Mr. W. V. Fitzgerald in the "Western Mail," Perth (9th June, 1906) accompanied by a photographic sketch, with the following note: "Is not uncommon from the eastern base of Mount Broome to the North, it being parasitic on species of *Tristania* and *Eugenia*."

Hosts.—Myrtaceae: *Eugenia eucalyptoides* F.v.M., *Tristania suaveolens* Sm.

EXPLANATION OF PLATES XVI.-XXVII.

Plate xvi.—*Loranthus Nestor* Moore.
Plate xvii.—*Loranthus Hilliana*, n.sp.
Plate xviii.—*Loranthus Lucasi*, n.sp.
Plate xix.—1-9. *Loranthus Quandang* (Lindl. MSS.).
10. *L. Quandang* var. *Bancrofti* Bail.
Plate xx.—*Loranthus Benthami*, n.sp.
Plate xxi.—*Loranthus Maideni*, n.sp.
Plate xxii.—*Loranthus Fitzgeraldi*, n.sp.
Plate xxiii.—*Loranthus grandibracteus* F.v.M.
Plate xxiv.—*Loranthus Britteni*, n.sp.
Plate xxv.—*Loranthus signatus* F.v.M.
Plate xxvi.—*Loranthus amplexans* (van Tiegh.).
Plate xxvii.—*Loranthus biangulatus* W. V. Fitz.

Plate xvi.—1. A flowering branch, nat. size (Comet Vale, J. T. Jutson, No. 247, 8/1917); 2. A bud; 3, 4. Bracts, front and back views; 5. A segment; 6. Fruit, nat. size; 7. Embryo.

Plate xvii.—1. Portion of branch, nat. size; 2. Bud; 3. Anther, front view; 4. Anther, back view; 5. Style; 6. Calyx, after anthesis.

Plate xviii.—1. Flowering branch, nat. size; 2. Bud; 3. Flower; 4. A bracteate peduncle with fruits in situ; 5. Fruit; 6. Seed, not. size; 7. Embryo.

Plate xix.—1. Flowering branch, nat. size; 2. A narrow leaf; 3. Flower, enlarged; 4. Vestiture of the flowers and young shoots; 5. Bud; 6. Lower portion of segment showing the callosity; 7. Fruit, enlarged; 8. Germinating seed; 9. Embryo, enlarged; 10. Leaf of var. *Bancrofti* from Eidsvold.

Plate xx.—1. Base of a young plant, showing union, nat. size, A, host, B, parasite; 2. Flowering branch, nat. size; 3. Portion of flowering branch, nat. size, Sunday Is.; 4. Flower, enlarged; 5. Fruit, nat. size; 6. Germinating seed, slightly enlarged.

Plate xxi.—1. Flowering branch, nat. size; 2. Common peduncle showing the two persistent and two deciduous bracts; 3. A deciduous bract; 4. Bud; 5. Flower; 6. Upper portion of segment; 7. Types of anthers; 8. Fruit, nat. size; 9. A germinating seed, nat. size; 10. Seed, with two radicles; 11. Embryo showing the cotyledons; 12. Germinating seed, much enlarged; 13. Common peduncle with two foliaceous bracts; 14. Leaf showing venation and vestiture.

Plate xxii.—1. Flowering branch, nat. size; 2. Bud; 3. Flower; 4. Upper portion of segment; 5. Anthers; 6. Fruit, nat. size; 7. Cyme with spent flowers; 8. Leaf showing the vestiture.

Plate xxiii.—1. Flowering branch, nat. size; 2. Buds and basal bract; 3. Bracts; 4. Flower; 5. Fruit, nat. size; 6. One of the foliaceous bracts, with young fruit in in situ; 7. Calyx and style.

Plate xxiv.—1. Flowering branch, nat. size; 2. Fruit, after Britten.

Plate xxv.—1. Flowering branch, nat. size; 2. The bracteate pedicel, enlarged; 3. Bud; 4. Flower; 5. Style; 6. Fruit, nat. size; 7. Embryo.

Plate xxvi.—1. Flowering branch, nat. size; 2. Anther; 3. Fruit.

Plate xxvii.—1. Flowering branch, nat. size; 2. Bud; 3. Flower; 4. Fruit, nat. size; 5. The persistent bracteate pedicel; 6. A young plant showing the cotyledons, nat. size; 7. A more advanced young plant, showing the attachment and the adventitious roots.

A CRITICAL REVISION OF THE AUSTRALIAN AND NEW ZEALAND SPECIES OF THE GENUS *SECOTIUM*.

By G. H. Cunningham, Government Mycologist, Department of Agriculture, Wellington, N.Z.

(*Communicated by Professor J. B. Cleland.*)

(Plates xii.-xv.; and sixteen Text-figures.)

[Read 30th April, 1924.]

There are a greater number of known species of this genus in Australia and New Zealand than anywhere else in the World, for of the 16 species discussed in this paper, 14 are confined to Australasia, and 2 occur also outside Australasia.

The following table will show the distribution of these species:—

Table of distribution of the Australasian species of Secotium.

Species.	Type locality.	Distribution.
agaricoides	Ukraine	W. Aust., N.Z. (?); America, Europe, Asia
cartilagineus	N.Z.	N.Z.
coarctatum	W. Aust.	W. Aust., S. Aust.
erythrocephalum	N.Z.	Tas., N.Z.
Guinzii	S. Africa	Tas.; S. Africa
Gunnii	N.Z.	Tas., N.Z.
leucocephalum	N.Z.	S. Aust., N.Z.
melanosporum	W. Aust.	W. Aust., S. Aust., N.S.W.
novae-zelandiae	N.Z.	N.Z.
ochraceum	Tas.	Tas.
porphyreum	N.Z.	N.Z.
piriforme	N.S.W.	N.S.W.
Rodwayi	Tas.	Tas.
scabrosum	Vic.	Vic.
superbum	N.Z.	N.Z.
virescens	N.Z.	N.Z.

All are saprophytes; for the most part they grow upon the ground, but certain species (*e.g., S. erythrocephalum* and *S. novae-zelandiae*) occur upon decaying wood.

Considerable confusion exists in mycological literature as to the taxonomic position of this genus; for example, De Toni (1888) placed it in the tribe Podaxineae of the family Lycoperdaceae, a classification generally followed. Fischer (1900) placed it in the Secotiaceae, a family he described to contain this and three other genera—*Cauloglossum, MacOwanites* and *Gyrophragmium*—although he himself has admitted it bears little resemblance to these genera, and that they bear little or no resemblance to one another. He also included the

genus *Polyplocium*, but this is a synonym of *Gyrophragmium*. Several claims have been put forward as to the position it should occupy; for example, Berkeley (1843) believed that *Secotium* and *Polyplocium* should be considered as connecting links between the Hymenomycetes and the Gasteromycetes; Fischer (1900) considered that the genus may have been an ancestral form of the Phallales, and would therefore consider it to have affinities with this family. Conard (1915), as a result of the study of the development of *S. agaricoides* (Czern.) Hollos, considered the genus to be related to *Psalliota*, as he believed it to be an arrested or paedogenic form, and would consequently place it in either the Agaricaceae or Marasmieae of Hennings (1897).

This genus must be retained in the Gasteromycetes for the following reasons:—

1. The development of the gleba in its first stages (until the formation of the first glebal cavity) agrees with that of *Psalliota* as described by Atkinson (1906, 1914, 1915), but later stages agree with the development of certain genera of the Hymenogastraceae, as, for example, *Hymenogaster*.
2. The hymenium is borne on the walls of tramal plates enclosing distinct lacunae, and not on or in structures which are wholly or in part exposed at maturity.
3. The hymenium, during the lifetime of the plant, is enclosed and the spores are set free only with the decay of the plant. Dehiscence at the base is given as one of the generic characters, but this must be interpreted in a broad sense, for although the margin of the peridium does in certain specimens separate from the base of the stipe, the spores do not become liberated, as the lacunae in this region are covered, even at maturity, by remnants of the partial veil. This structure serves as an effective cover over the exposed lacunae. Furthermore, only a minute portion of the gleba becomes exposed when this separation occurs, for the majority of the lacunae are remote from the stipe. The plants may in reality be considered to be indehiscent.
4. A distinct columella is always present and is, in part, united to the gleba during the lifetime of the plant, forming a definite and characteristic part of its structure.

In fact, were these plants devoid of columella and stipe, they would without hesitation be included in the Hymenogastraceae. On account of the nature of the basidia and spores, the structure of the gleba, and the presence of a definite stipe and columella, the genus forms a well defined group. The presence of the stipe and columella, together with the similarity of the early developmental stages, link it with the Agaricales, whereas the nature of the gleba and peridium link it with the Hymenogastraceae. It would, therefore, appear to occupy an intermediate position, and as no known genera connect it closely with either family, it should be placed in a distinct family. The family Secotiaceae of Fischer (1900*a*) would suffice, if emended to include those genera possessing a stipe, columella, persistent cellular gleba, tetrasporous sterigmate basidia, and to exclude any genera possessing a capillitium.

Structure of the mature plant.

S. erythrocephalum represents the genus as now defined fairly well; it is probably the most abundant species known, and has been well described and figured by the brothers Tulasne.

A mature plant consist of (*a*) peridium, (*b*) gleba, (*c*) stipe.

(*a*) *Peridium* (Pl. xiv., fig. 1, *p*) may be depressed-globose or ovate, and attain a diameter of 5 cm. In structure it is thick, coriaceous and in this species coloured bright scarlet. Externally it is covered with a gelatinous layer, formed of hyphae which have become gelatinised. The first few external layers of the peridium contain the colouring matter. This is in the form of fine granules, embedded in the protoplasm lining the hyphal walls. At the apex the peridium is about 3 mm. thick; it tapers to the base, where the margin is usually incurved and closely pressed to the stipe, being held in position in adult plants by the few remaining hyphae of the partial veil. Frequently the margin is lacerate, and sometimes it may be decurrent.

(*b*) *Gleba* (Pl. xiv., fig. 1, *gl*).—This constitutes the body of the peridium. It consists of very numerous tramal plates, which ramify through the interior, anastomosing at frequent intervals to enclose irregular lacunae. The walls enclosing the lacunae are lined with the hymenium, which consists of basidia closely compacted together in the form of a palisade layer. The tramal plate is composed of three classes of tissue: (1) an inner layer of parallel hyphae, the trama (Text-fig. 1, *tr.*), (2) a layer on either side of this composed of small irregularly polygonal cells, comprising the sub-hymenium (Text-fig. 1, *sub.*), and (3) the palisade layer of basidia (Text-fig. 1, *hym.*). When mature, each basidium bears on its distal end four slender sterigmata, to the apices of which the spores are attached. The spores are smooth, coloured and continuous. The structure of the gleba varies with the species; for example, in the species under discussion it is cellular, but in others it may be lamellar (*S. agaricoides*), or labyrinthiform (*S. porphyreum*).

(*c*) *Stipe* (Pl. xiv., fig. 1, *st*).—The stipe is well developed in most species, is central, and extends from the substratum to the apex of the plant, where it merges with the peridium. The portion which passes through the gleba is termed the *columella* (Pl. xiv., fig. 1, *col.*), the anterior half of which, during the lifetime of the plant, is united with the gleba, and is not separable from it. The lower portion of the columella is surrounded by a conical cavity which extends from the base of the peridium to about half-way into the gleba. The portion of the columella which merges with the gleba is solid, but the portion below this, together with the stipe, is in this species always hollow. In two species the stipe is solid throughout, whilst in others the cavity may be filled with loosely woven hyphae. Frequently the apex of the columella is thickened somewhat, especially in those species which are umbilicate. The stipe is attached to the substratum by coarse, coloured or white rhizoids; in certain species, as the one under discussion, these may extend for several centimetres from the point of attachment, and it is from these rhizoids that the various developmental stages may be obtained.

Dehiscence is supposed to be effected by the separation of the base of the peridium from the stipe. Although this separation often occurs, it does not result in the liberation of the spores, since most are enclosed within cavities remote from the base of the peridium and those cavities adjacent to or adjoining the base of the peridium are not always exposed, being commonly covered by the remains of the partial veil (Pl. xv., fig. 2). Therefore, as the plants are dependent on decay for the release of the spores, they are in reality indehiscent.

Decay of the plants, in New Zealand at any rate, is readily and rapidly effected by the larvae of an insect which, in the course of a few days, convert the whole of the gleba into a viscid mass. In fact, so rapid is the destruction wrought by these larvae, that they will completely destroy a collection within 48

hours. It is probable that they serve in some measure to disseminate the spores. Slugs, too, probably are instrumental in the dissemination of the spores, for many plants, especially of *S. novae-zelandiae*, are frequently found to be much damaged by these animals.

Development and Cytology.

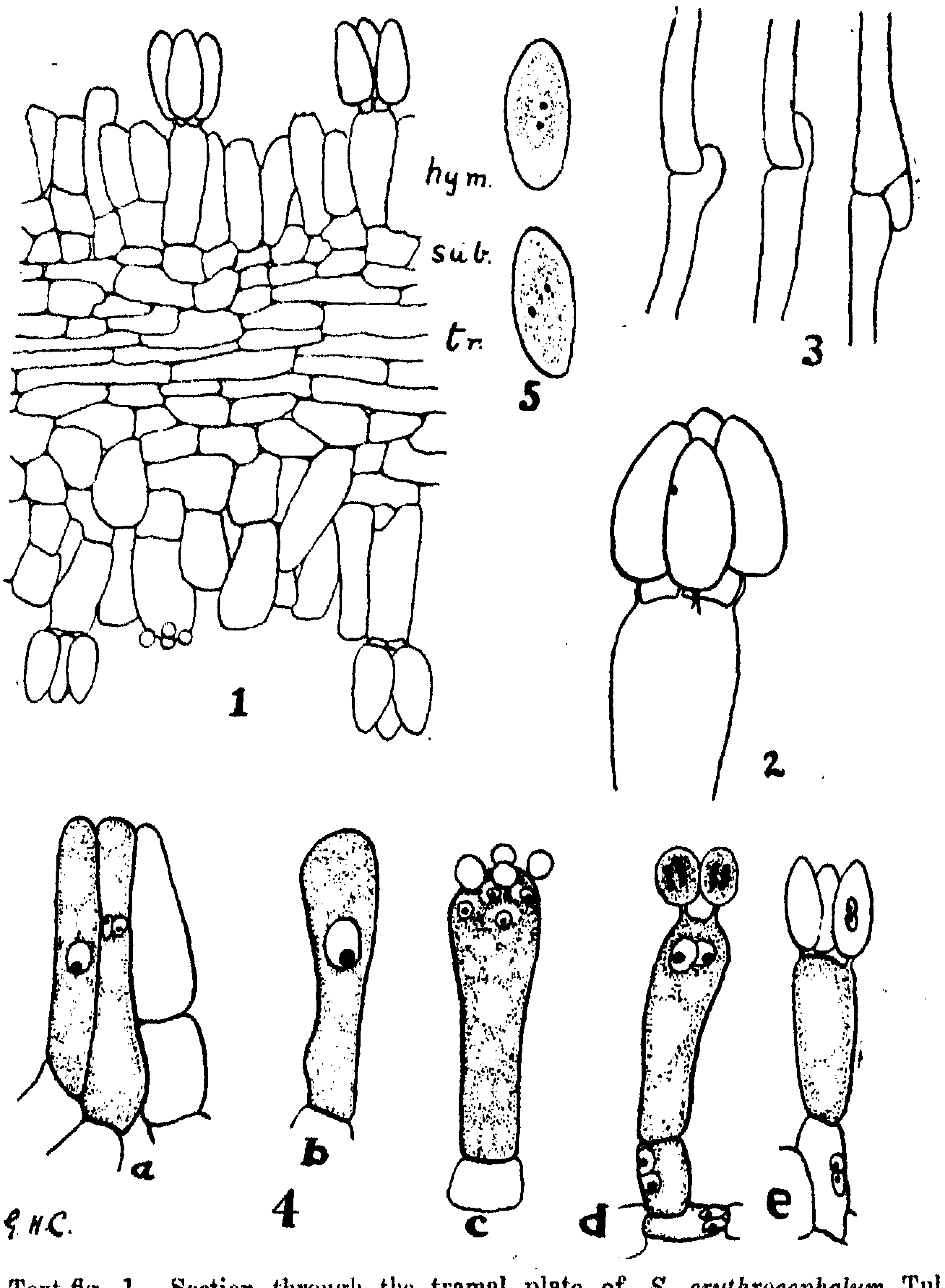
The writer has recently carried out an investigation into the development of *S. erythrocephalum* and *S. novae-zelandiae*, the detailed results of which will be published elsewhere. An abbreviated description of the developmental stages of the latter species will be given here since it embraces a more complete series and since the development of the two species differs only in minor details.

Numerous specimens in all stages of development were obtained from rhizoids springing from mature plants. These were fixed in picro-formol, sectioned, and stained in iron-alum haematoxylin, followed by 1% iodine green in clove oil.

Young plants are first noticeable as small white swellings on the rhizoids. Sections show these swellings to consists of intricately woven, undifferentiated hyphae. They continue to grow slowly until they are about 2 x 1 mm., when sections show that differentiation has commenced. The stipe is the first to become differentiated, and is at this stage recognisable on account of the parallel arrangement of its component hyphae. In the undifferentiated apical region (the primordium of the peridium and gleba) appears a small compact area of deeply staining hyphae. In this area a small radial cavity appears (Pl. xii., fig. 1), followed by differentiation of the lower portion of the columella. In the glebal cavity a palisade of closely compacted hyphae appears, and simultaneously, extending downwards from the floor of the cavity to the upper and outer margin of the stipe, appears a wedge-shaped radial area (Pl. xii., fig. 2), noticeable on account of the hyphae of which it is composed being less closely compacted. This is the partial veil. No further growth occurs in this region, so that as the stipe and columella increase in size, the hyphae composing the partial veil become more and more drawn apart, until at maturity a few only persist, holding the base of the peridium in contact with the stipe. Fragments of the veil persist on the periphery of the stipe, giving to it a somewhat fibrillose appearance.

Following the appearance of the first glebal cavity, the stipe makes little growth until the plant is about one-quarter the normal size. Then it commences to thicken, and after a time to elongate. The cavity of the stipe appears shortly after the first glebal cavity (Pl. xii., fig. 3). The columella gradually grows, becoming slowly differentiated from the primordial tissues of the gleba until the plant is about one-quarter grown, when it merges with the peridium, which is not differentiated until about this time.

The palisade layer of the glebal cavity extends around the walls of the cavity until it almost surrounds it; then outgrowths grow downward from the roof and merge with the side walls, dividing the original cavity into several smaller ones (Pl. xii., figs. 3-4). At the same time small lacunae begin to appear in the undifferentiated portion of the gleba above the original cavity (Pl. xii., fig. 4). These become lined with the hymenium and spores begin to appear on the first formed palisade (Pl. xii., fig. 2). Further differentiation of the gleba consists in the continuous appearance of these lacunae (Pl. xii., fig. 5; Pl. xiii., fig. 1), until the whole of the area enclosed within the peridium is perforated with them. These lacunae also appear in the tramal plates, which become thinner in consequence. Colour now appears in the exterior cells of the peridium, it enlarges rapidly, and at the same time is carried upwards by the



Text-fig. 1. Section through the tramal plate of *S. erythrocephalum* Tul. *hym.*, hymenium; *sub.*, subhymenium; *tr.*, trama. (x 1000).

Text-fig. 2. Basidia of *S. novae-zelandiae* G. H. Cunn. (x 1500).

Text-fig. 3. Clamp connections from partial veil of *S. novae-zelandiae* G. H. Cunn. (x 1000).

Text-fig. 4. Nuclear phenomena of *S. erythrocephalum* Tul. (x 1000). *a.* Nucleus of basidium before (left) and after division (right) preceding nuclear fusion; *b.* fusion nucleus; *c.* 4 nuclei in distal end of basidium prior to migration into spores; *d.* 2-spored basidium from which 2 nuclei have migrated; they are shown in the spores, in mitosis; *e.* nearly mature spores showing binucleate condition.

Text-fig. 5. Two binucleate spores of *S. erythrocephalum* Tul. (x 1000).

rapid elongation of the stipe. So that at maturity, the plant stands well above the substratum, and the gleba consists of plates surrounding very minute lacunae.

It is thus seen that the early stages, until the appearance of the first glebal cavity, resemble the development of *Psalliota* (= *Agaricus*), but from this stage onwards further differentiation of the gleba is similar to that of certain genera of the Hymenogastraceae, notably *Hymenogaster*.

Cytology (Text-figs. 2-5).

The hyphae of the columella, stipe and peridium are invariably bi-nucleate. The basidia at first are binucleate, these nuclei fuse, and a slightly larger fusion-nucleus is formed. This takes up a position in the distal end of the basidium; there it divides twice. The first division precedes the formation of the sterigmata, the second succeeds their appearance. When the sterigmata are about half their normal length, spores begin to appear on them, and when they are full length, the spores are about half size. When the spores are about one-quarter their normal size, a nucleus migrates into each, divides mitotically, and the spore becomes binucleate, a character constant in each of the numerous species examined. The spore attains its full size before it changes colour; at maturity the epispore becomes coloured some shade of brown, the depth of colour depending on the species.

Clamp connections are abundant in the tissues of the stipe and partial veil (Text-fig. 3).

On germination a germ tube protrudes, usually from the end of the spore opposite to that by which it was attached to the sterigma; this branches repeatedly to form a mycelium, the cells of which are septate and binucleate.

Determination of Species.

Species of this genus have proved most difficult to determine since the earlier writers, who based species on the external characters of the peridium and stipe alone, confined their descriptions to the shape, size and colour of the peridium, and the length and colour of the stipe. This was sufficient when but two or three were known, but, as the number of species increased, it became obvious that these characters were often of insufficient value in themselves, since they are decidedly variable, even in the same collection. Certain later workers have gone to the other extreme, and based species on spore characters alone, other characters being presumably considered of minor importance. This again makes determination difficult as several species, widely different in macroscopic, agree very closely or are identical in microscopic characters. For the determination of species in the field, a knowledge of macroscopic characters is essential; on the other hand, the shape, size and colour of the peridium and stipe are of little value to anyone working with herbarium material, for these characters may become wholly altered in drying. Therefore, with herbarium material, a knowledge of those characters which are not changed during drying is essential; and, as the spores and gleba undergo little alteration, their structure, colour, and other characters are invaluable aids to the systematist. Unfortunately the artificial keys in taxonomic papers are generally based on a combination of macroscopic and microscopic characters and consequently are valueless for use either in the field or in the herbarium. The difficulty of preparing an artificial key becomes apparent when the factors upon which species are based are considered, for rarely is a species described on any one character alone, but usually on the sum of two or three minor characters.

It is not claimed that the following key will enable anyone to determine a species with certitude; but it is used in this paper mainly for the purpose of dividing the genus into groups, for in a key of this nature all closely related species are brought together, when their characteristics become more apparent.

Acknowledgments.

The writer wishes to thank the following:—Professor J. B. Cleland, Adelaide, Mr. L. Rodway, Government Botanist, Hobart, and Mr. E. Cheel, Botanic Gardens, Sydney, for the loan of specimens in their possession; Professor Cleland, Mr. Rodway, Dr. J. R. Weir, Bureau of Plant Industry, Washington, and Messrs. J. C. Neill, E. H. Atkinson, J. G. Myers, for donations of specimens; and especially Mr. Neill for the preparation of all microscopic material used in this work.

All the descriptions given below are original, unless otherwise stated, and have been drawn up from material examined by the writer. It is believed that all species of this genus known to occur in Australasia have been examined.

Secotium Kunze.

Flora, xxiii., 1840, p. 321.—*Endoptychum* Czern., Bull. Soc. Imp. Nat. Moscou, xviii., 1845, p. 146.

Peridium stipitate, variously shaped, consisting of a single thick layer often externally brightly coloured; margin at first entire, appressed to the stipe, becoming somewhat lacerate, and in some species separate from the stipe.

Stipe central, long or almost obsolete, inserted in a depression in the base of the peridium, hollow, stuffed or solid; continuing as a columella to the apex of the peridium.

Gleba cellular, labyrinthiform or lamellar, permanent, indehiscent, consisting of numerous anastomosing plates enclosing irregular lacunae; hymenium lining free surfaces of plates; cystidia or other aberrant cells absent. Basidia commonly tetrasporous, spores borne on slender sterigmata, variously shaped, continuous, hyaline or coloured, rough or smooth, binucleate.

Habitat.—Saprophytic upon decaying humus in the ground, or upon rotting wood buried in the substratum; commonly in shady and damp places.

Distribution.—North and South America, Africa, Europe (excluding Britain), Asia, Australia and New Zealand.

About 22 species have been recorded, 11 of which have been collected in Australia and New Zealand. Sixteen species (including 5 described as new) are discussed in this paper, all but 2 of them being confined to Australasia.

Species of the genus are characterised by the structure and permanent nature of the peridium, and the presence of a definite stipe and columella. The peridium consists of a single coriaceous cortex. The gleba is cellular, and consists of tramal plates anastomosing at various points, enclosing irregular cavities or lacunae, the inner walls of which are lined with the hymenium. The stipe is usually well defined and traverses the gleba as a columella. Plants are commonly epigean, but one or two species are known which are at first subterranean, and approach the surface only when they near maturity; a New Zealand example is *S. porphyreum.* One Tasmanian species, *S. Rodwayi*, is said to be truly hypogeal and is exposed only (?) by burrowing marsupials. Another peculiarity worthy of note is that whereas most of the New Zealand species are brightly coloured, the Australian species, with the exception of *S. piriforme*, are some shade of grey or brown.

Fischer (1900) has included the genus *Elasmomyces* Cav. as a synonym of *Secotium*, but the presence of cystidia in the hymenium would serve as a character sufficiently important to warrant its separation, for of the 15 Australasian species examined by the writer, not one possesses cystidia.

Artificial Key to the Species.

- Spores smooth.
  - Peridium smooth, usually viscid.
    - Gleba ochraceous or ferruginous.
      - Peridium some shade of blue or green.
        - Stipe long, 3 cm. or more .. .. 1. *S. superbum.*
        - Stipe short, 2 cm. or less .. .. 2. *S. virescens.*
      - Peridium scarlet .. .. 3. *S. erythrocephalum.*
    - Gleba chocolate or sepia-coloured .. .. 4. *S. novae-zelandiae.*
  - Peridium rough; scabrid, hispid or tomentose.
    - Gleba tan, ochraceous or ferruginous.
      - Spores over 10 μ .. .. 5. *S. ochraceum.*
      - Spores under 10 μ .. .. 6. *S. coarctatum.*
    - Gleba bronze or almost black.
      - Stipe long, 3 cm. or more .. .. 7. *S. melanosporum.*
      - Stipe short, 2 cm. or less .. .. 8. *S. agaricoides.*
- Spores rough.
  - Peridium smooth, usually viscid.
    - Stipe solid.
      - Stipe long, 3 cm. or more .. .. 9. *S. leucocephalum.*
      - Stipe short, 2 cm. or less .. .. 10. *S. Gunnii.*
    - Stipe hollow.
      - Stipe long, 3 cm. or more.
        - Spores over 10 μ .. .. 11. *S. porphyreum.*
        - Spores under 10 μ .. .. 12. *S. Guinzii.*
      - Stipe short, 2 cm. or less .. .. 13. *S. piriforme.*
  - Peridium rough; scabrid, hispid or tomentose.
    - Gleba cellular.
      - Spores over 10 μ .. .. 14. *S. cartilagineus.*
      - Spores under 10 μ .. .. 15. *S. Rodwayi.*
    - Gleba lamellar .. .. 16. *S. scabrosum.*

All drawings and photographs are original; the drawings of spores have been made with the aid of a camera lucida, and are all x 1,000 diameters. I have not presented photographs of dried plants, as they are worthless for illustrative purposes.

1. Secotium superbum, n.sp. (Pl. xiv., fig. 2; Text-fig. 6a.)

Peridio caeruleo, griseo-viride vel viride, conico, apice acuto, ad 8 cm. alto, 4 cm. lato, primum pruinoso demum glabro, leve. Stipite aurantio, ad 5 cm. longo, 12 mm. crasso, leve, glabro, excavato. Gleba brunnea, cellulosa. Sporis levibus, pallido-brunneis, ovatis vel ellipticis, 14-18 x 6-8 μ.

Hab.: Solitarii ad terram in locis gramineis.

Otaki Forks, Upper Otaki River, Wellington, N.Z. 300 m. J. G. Myers, E. H. Atkinson.

Peridium azure, sage-green or sea-green, sometimes mottled with pallid spots, conical, apex sharply acuminate, base strongly excavated, truncate, or more frequently margin decurrent, up to 8 cm. high, and 4 cm. wide, at first pruinose, becoming glabrous, polished and slightly viscid; drying dull green or olivaceous.

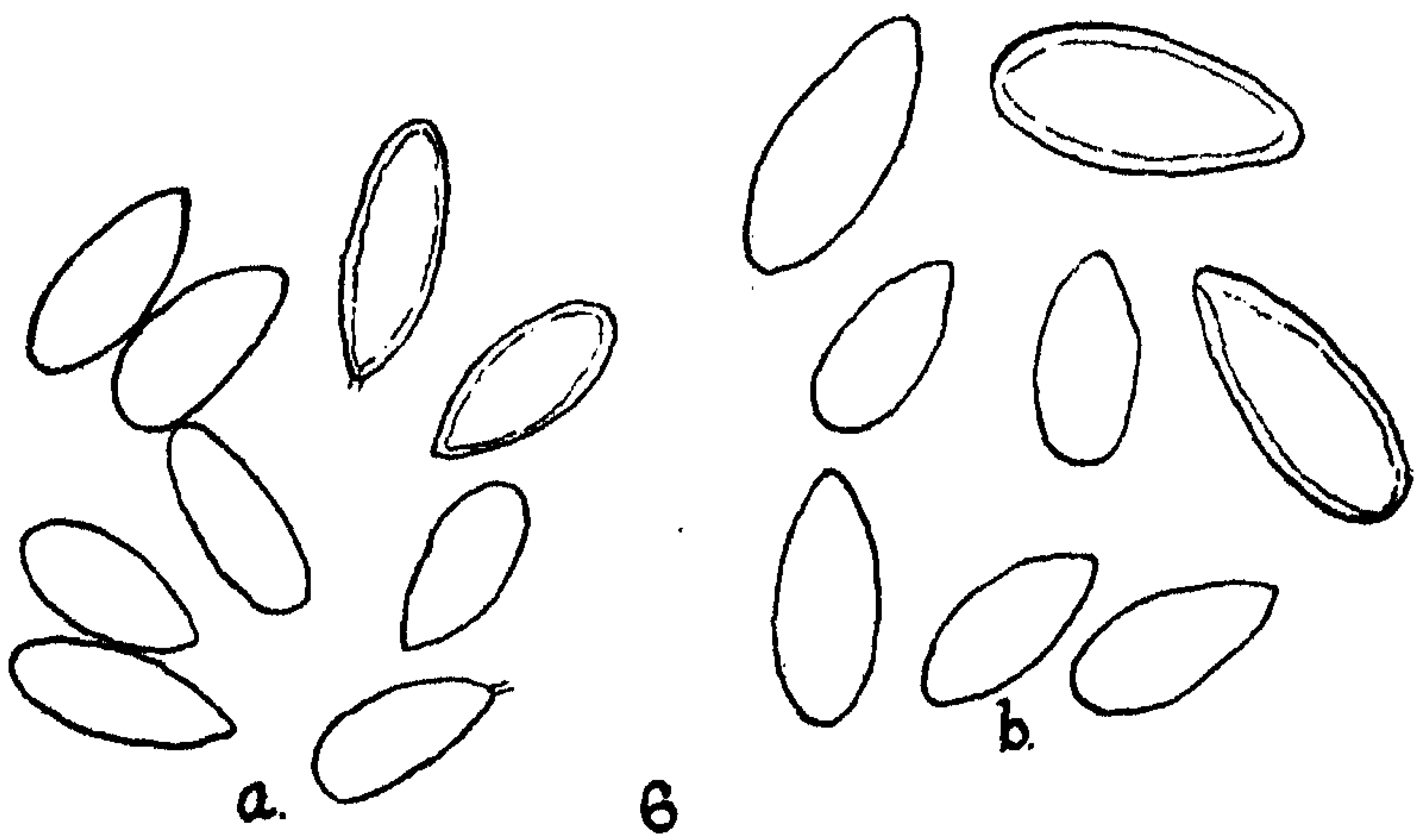
Stipe bright yellow, stout, up to 5 cm. long, and 12 mm. wide, tapering from base to apex, smooth, shining, hollow; columella slightly thickened at the apex.

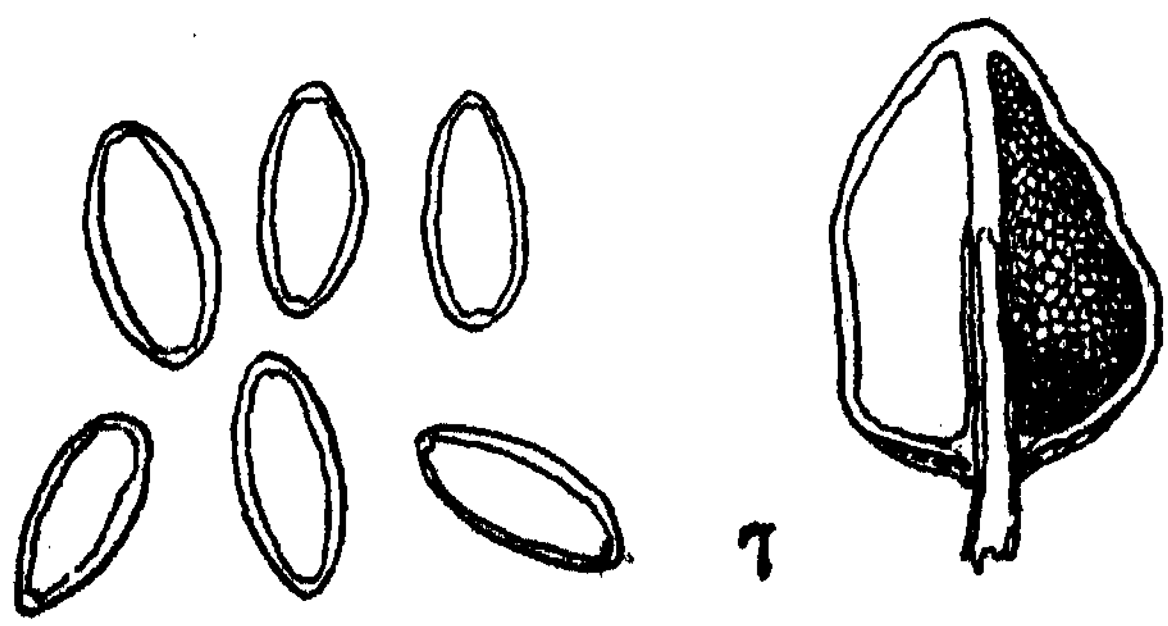
Gleba ferruginous, cellular, cells 2-4 mm. long, laterally compressed, dissepiments thin.

Spores smooth, pallid ferruginous, ovate or elliptical, one end rounded, the other pointed, frequently shortly pedicellate, 14-18 x 6-8 μ, epispore thin.

Habitat.—Solitary on the ground in grassy places in the forest.

Distribution.—Otaki Forks, Upper Otaki River, Wellington, N.Z. (300 m., J. G. Myers, E. H. Atkinson, 8/7/22. Type), Forest Reserve, Whakatikei, Paekakariki, Wellington, N.Z. (45 m., J. G. Myers, J. C. Neill, 16/6/23). Collections in the herbarium of the writer, Nos. 922, 1094.





Text-fig. 6. *a.* Spores of *S. superbum.* (x 1000). *b.* Spores of *S. erythrocephalum* Tul. (x 1000).
Text-fig. 7. *S. virescens* Mass. Plant (nat. size); spores (x 1000).

The large conical peridium, stout yellow stipe and large smooth spores characterise this species. It closely resembles the following species, but is separated on account of the shape and large size of the peridium. It is a magnificent species, the azure peridium and yellow stipe being very conspicuous. The base of the peridium does not as a rule separate from the stipe, but remains

closely pressed to it. This is one of the largest species known, and should be readily determined on this account.

2. SECOTIUM VIRESCENS Massee. (Text-fig. 7.)

Mass., Grevillea, xix., 1890, p. 47; Sacc., Syll. Fung., ix., 1891, p. 266.

Peridium pallid sage-green, ovate or broadly conical, apex obtusely acuminate, base abruptly rounded, slightly or not excavated, 2-3 cm. high, 2-2.5 cm. broad, coriaceous, glabrous, shining, with occasional longitudinal furrows, margin lacerate, somewhat decurrent; drying dull green.

Stipe greyish-white, short (almost obsolete in the specimen examined), about 5 mm. long, hollow, smooth, glabrous, tapering from base to apex; columella slightly expanded at the apex.

Gleba ferruginous, cellular, cells regular, laterally compressed, 2-3 mm. long, dissepiments thin, enclosed within a dense purplish-brown layer within the wall of the peridium.

Spores smooth, pallid ferruginous, elliptical, ends bluntly pointed, 15-18 x 7-8 μ (Massee 18-20 x 7-8 μ; Cleland 14.5-16 x 8 μ), epispore thin.

Habitat.—Solitary on the ground in rain forest.

Distribution.—Dannevirke, N.Z. (W. Colenso. Type, in Herb. Kew). Locality unknown (T. Kirk. Specimen in Herb. Kew), Bluff, Southland, N.Z. (J. B. Cleland, 10/6/22. Specimen in Herb. Cleland).

This species is characterised by the colour of the peridium and gleba, short, almost obsolete stipe and the large size of the spores. The plant somewhat resembles the preceding.

I am indebted to Dr. Cleland for the loan of the specimen from which the above description has been drawn up. In a note accompanying the specimen he has given details as to the colour, shape and size of the peridium when collected, and these have been incorporated in the above description.

This species was originally described from material forwarded to Kew by Colenso. It is apparently rare, for, with the exception of one collection made by the late Mr. T. Kirk, Dr. Cleland's plant is the only collection made since the species was described.

3. SECOTIUM ERYTHROCEPHALUM Tulasne. (Pl. xiii., fig. 2; Text-fig. 6*b*.)

Ann. Sci. Nat., ser. 1, vol. 3, 1844, p. 115.—Sacc., Syll. Fung., vii., 1888, p. 54; xi., 1895, 158; Mass., Grev., xix., 1890, p. 96; Cke., Hdbk. Aus. Fung., 1892, p. 221; Lloyd, Lyc. Aus., 1905, p. 6, t. xxvi., f. 1-6.

Peridium scarlet, globose, depressed-globose or ovate, apex obtuse or rounded, base excavated, truncate or decurrent, 2-4 cm. high, up to 6 cm. wide, smooth, frequently somewhat lobed, glabrous, shining, often slightly viscid; retaining its colour when dried.

Stipe bright yellow, slender, up to 10 cm. long, 3-10 mm. thick, equal, smooth or fibrillose, often polished, hollow; columella slightly expanded at the apex.

Gleba ferruginous, cellular, cells polygonal or slightly elongate, up to 3 mm. long, numerous, dissepiments thin.

Spores smooth, pallid ferruginous, elliptical or elliptic-ovate, bluntly pointed at one or both ends, 12-25 x 7-11 μ, (Tulasne, 12 x 5 μ; Massee 10-11 x 5 μ; Lloyd, about 12 x 6 μ).

Habitat.—Gregarious or solitary on decaying wood on the forest floor.

Distribution.—Tasmania; N.Z. (Herb. Nos. 120, 610, 938, 1097). Common throughout the lowland forests of New Zealand.

I have collected this species at Auckland, Hamilton, Cambridge, Rotorua, Te Aroha (Auckland Province); Weraroa, Mt. Waiopehu, York Bay and Botanical Gardens (Wellington Province); and have received collections from Peel Forest (from Dr. H. H. Allan), and Governors Bay (from Mr. J. F. Tapley), Canterbury Province; and Dun Mt., Nelson Province (from Mr. J. C. Neill). It is not confined to the forest, for several collections have been obtained from flower gardens, especially where these have been at one time in forest. It is commonly stated that this species grows on the ground; but although I have collected hundreds of these plants, I have always found them to be attached to decaying wood.

The scarlet colour of the peridium separates this from any other species, but in glebal and spore characters it is closely allied to *S. virescens* and *S. superbum.*

The spore measurements I have given are much greater than those given by other writers. But with certain large forms found here, spores of a length of 25 μ are not uncommon. I believe that it would be inadvisable to separate these forms, for they are identical in all other respects. Furthermore, intermediate stages, in which the spores vary in size between the large and small spore forms, are not uncommon.

This species was named by Tulasne from material collected at Akaroa, Banks Peninsula, Canterbury, by Raoul, now preserved in the museum herbarium at Paris.

4. SECOTIUM NOVAE-ZELANDIAE, n.sp. (Pl. xiii., fig. 3; Text-fig. 8*a*.)

Peridio pallido-griseo vel pallido-viride, ovato vel elliptico-oblongo, apice acuto vel obtuso, 3-5 cm. alto, 1.5-3 cm. lato, primum fibrilloso demum leve, glabro. Stipite pallido-griseo vel pallido-viride, 4 cm. longo, 6 mm. crasso, glabro, excavato. Gleba brunneo-nigra, cellulosa vel lamelliforma. Sporis brunneo-nigris, elliptico-ovatis, vel ellipticis, levibus, 11-15 x 5-8 μ.

Hab.: Solitarii vel gregarii ad lignis in silvis.

Weraroa, Wellington, N.Z. 100 m. G.H.C.

Peridium commonly french-grey, changing in old specimens to pallid-green, ovate or elliptic-oblong, apex bluntly acuminate or obtuse, base bluntly rounded, or decurrent, 3-5 cm. high, 1.5-3 cm. wide, at first finely fibrillose, fibrils longitudinally arranged, so that the surface appears striate, becoming smooth, glabrous, polished and slightly viscid, coriaceous; margin folded and frequently lacerate, drying dingy brown.

Stipe pallid french-grey or tinted bluish-green, yellowish at the base, slender, up to 4 cm. long, and 6 mm. thick, equal, at first fibrillose, becoming glabrous and polished, save at the base, hollow; columella thickened at the apex.

Gleba chocolate- or sepia-brown, coarsely cellular, sometimes lamellar, cells elongated, up to 10 mm., sparse, laterally compressed, dissepiments thin.

Spores smooth, sepia-coloured, elliptic-ovate or elliptical, rounded at one end, 11-15 x 5-8 μ, epispore thin.

Habitat.—Solitary or crowded on decaying wood buried in the substratum. In lowland rain forest.

Distribution.—Weraroa, Wellington, N.Z. (100 m., G.H.C. 1/8/19. Type), Weraroa (E. H. Atkinson, 20/8/19; J. C. Neill, G.H.C., 2/5/23), Forest, Bo-

tanical Gardens, Wellington (80 m., G.H.C., May, Aug., 1922). Specimens in the herbarium of the writer, Nos. 872, 874, 1098.

The sepia colour of the gleba serves to separate this from any other species in this section. It is fairly abundant in the early winter and spring months in lowland mixed rain-forest near Wellington. It occurs only on decaying wood, principally on rotting branches of *Melicytus ramiflorus* Forst. I have recently obtained a very complete suite of developmental stages, from which the abbreviated account of its development has been drawn up. The plant is usually covered with dried leaves, and so difficult to find unless these be first removed. It is readily eaten by slugs, and it is in consequence often difficult to find mature specimens that have not been injured by these animals.

The shape of the peridium varies considerably in different specimens, for one may obtain ovate, elliptical or even depressed-globose plants. When the plant is ovate, the columella is usually considerably thickened at the apex. Another variable feature is the gleba, which may in certain specimens be cellular, whilst in others it may be lamellar, approaching in extreme cases the gleba of *S. agaricoides*. As all intermediate stages may be collected it is impossible to segregate these forms, save at the extremes.

5. SECOTIUM OCHRACEUM Rodway. (Text-fig. 8*b*.)

Proc. Roy. Soc. Tas., 1919 (1920), p. 112.

Peridium pale ochre-brown, subglobose, base slightly excavated, 1-2 cm. diam., tomentose, very thin, hardly apparent; drying dingy brown, becoming rugulose.

Stipe short, 3-5 mm. long, 2 mm. thick, pallid brown, equal, tomentose, hollow; columella not expanded at the apex.

Gleba ochraceous, labyrinthiform, cells minute, 1-2 mm. long, dissepiments thick.

Spores smooth, pallid ferruginous, elliptical, bluntly pointed at both ends, 12-17 x 6-9 μ (Rodway 16 x 8 μ).

Habitat.—Subterranean, solitary.

Distribution.—Cascades, Hobart (L. Rodway. Type). Specimens in Herb. Rodway, No. 933.

The ochraceous gleba with its labyrinthiform lacunae, and the large elliptical spores, characterise the species. The subterranean habit is a character worthy of note.

I am indebted to Mr. Rodway for the loan of his type specimens from which the above description has been drawn up.

6. SECOTIUM COARCTATUM Berkeley. (Text-fig. 9.)

Berk., Hook. Jour. Bot., iv., 1845, p. 63, t.i., f. 3.—Cda., Icon. Fung., vol. 6, 1854, t. vi., f. 25-30; Sacc., Syll. Fung., vii., 1888, p. 150; Cke., Hdbk. Aust. Fung., 1892, p. 220; Lloyd, Lyc. Aus., 1905, p. 7; Cleland, Trs. Roy. Soc. S. Aust., xlvii., 1923, p. 74.

Peridium pallid greyish-brown, obovate or depressed-globose, umbilicate, base strongly excavated and truncate, up to 12 mm. high, 12-20 mm. wide, rugulose, minutely and densely tomentose, coriaceous, thick; pallid brown and rugulose when dried.

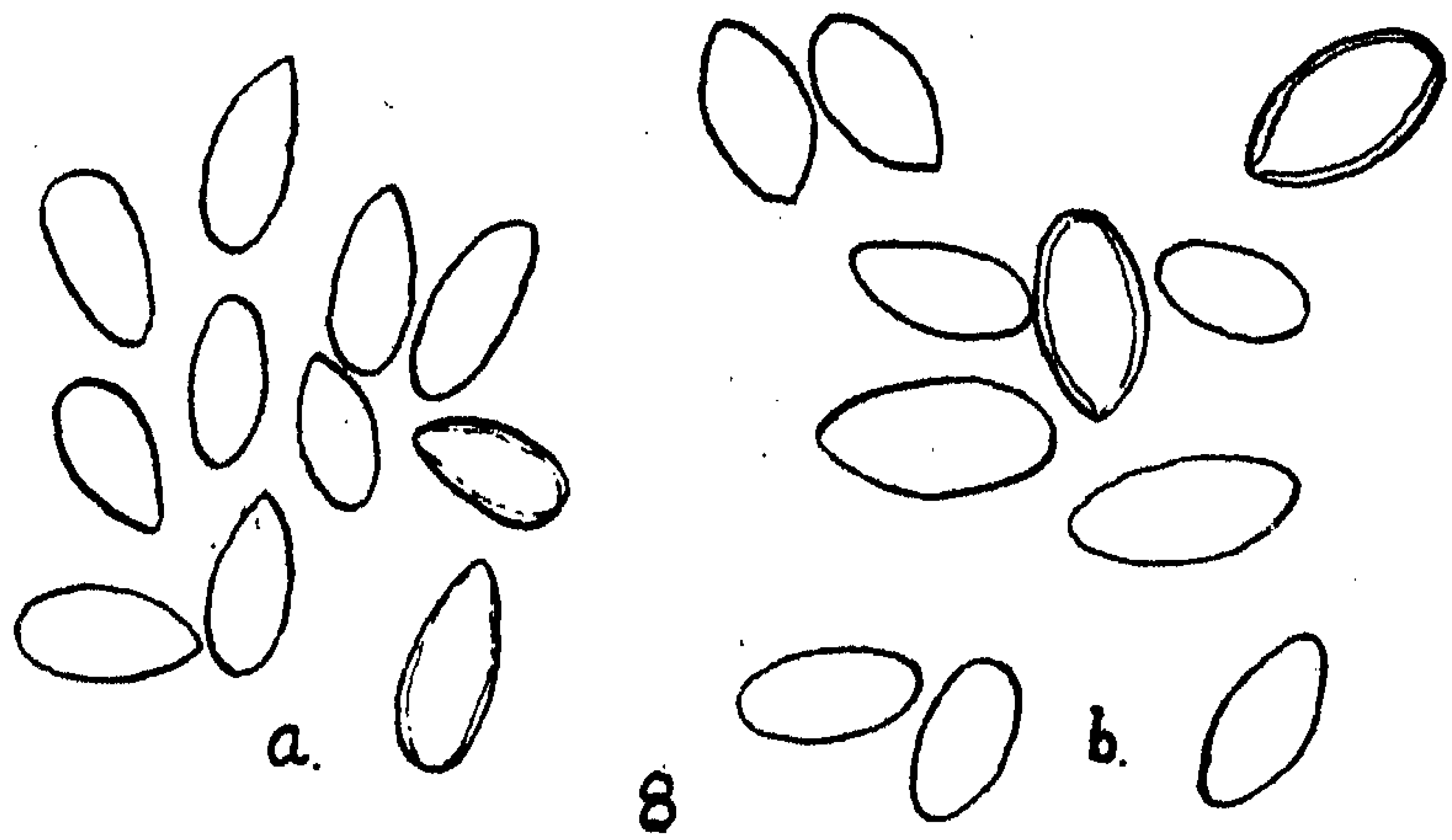
Stipe greyish, up to 2 cm. high, usually shorter, 2-3 mm. thick, glabrous or tomentose, tapering from base to apex, hollow or stuffed; columella thickened at the apex.

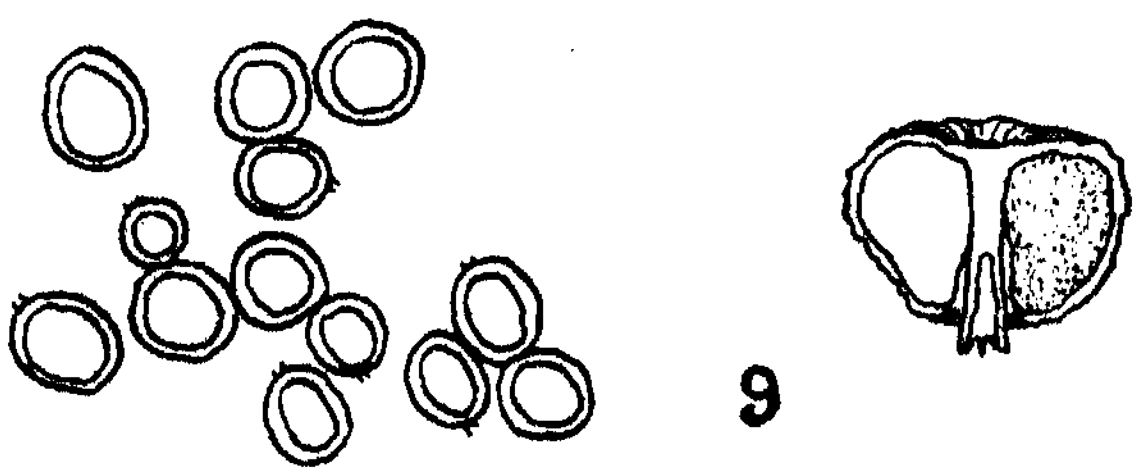
Gleba pallid grey or tinted tan colour, labyrinthiform, cells very minute, up to 0.5 mm. long, very numerous, dissepiments very thin, whole gleba crumbling readily when cut.

Spores smooth, tinted yellow, almost hyaline, subglobose to ovate, shortly pedicellate, 5-8 μ diam. (Berkeley, 5-7 μ; Cleland, 5-7 μ; Lloyd, 6 x 5 μ), epispore thick.

Habitat.—Solitary on the ground.

Distribution.—Swan River, W. Aust. (Drummond. Type, in Kew Herb.), Narrabri, N.S.W. (J. B. Cleland, 2/6/19), Adelaide, S. Aust. (Miss Joan Cleland, 20/5/23). Material in Herb. Cleland.





Text-fig. 8. *a.* Spores of *S. novae-zelandiae.* (x 1000); *b.* Spores of *S. ochraceum* Rodw. (x 1000).

Text-fig. 9. *S. coarctatum* Berk. Plant (nat. size); spores (x 1000).

Characterised by the pallid colour and minute cells of the gleba, pallid colour and tomentose surface of the peridium, and small, smooth, subhyaline spores.

I am indebted to Dr. Cleland for the loan of the material from which the above description has been drawn up. In a note accompanying the specimens he stated that the plant possesses a strong and pleasant odour, especially noticeable when freshly collected. This odour apparently disappears from old material, however, for I have been unable to detect it in the material at hand.

The peculiar nature of the gleba is worthy of note, for this structure is present in no other species. Apart from its light colour and minute cells, it is

extremely friable, crumbling so readily before the razor as to make it a difficult matter to obtain a section.

Lloyd (1905) believes *S. Gunnii* to be a synonym, but this is not the case, for the glebal characters are quite different; the rough spores of *S. Gunnii* alone are sufficient to separate it.

7. SECOTIUM MELANOSPORUM Berkeley. (*Pl.* xv., *fig.* 1; *Text-fig.* 14*a*.)

Berk., Hook. Jour. Bot., iv., 1845, p. 62, t.i., f. 2.—Cda., Icon. Fung., vol. 6, 1854, t. vi., f. 19-24; Sacc., Syll. Fung., vii., 1888, p. 54; Cke., Hdbk. Aust. Fung., 1892, p. 220; Lloyd, Lyc. Aust., 1905, p. 7, t. xxvi., f. 9-12; Myc. Notes, 1922, p. 1116, f. 2111; Cleland, Trs. Roy. Soc. S. Aust., xlvii., 1923, p. 73.

Peridium dingy-grey, darker above, strongly depressed-globose, deeply umbilicate, base deeply excavated, truncate, 3-4 cm. high, up to 3 cm. wide, finely scabrid and longitudinally striate; dingy-grey and minutely rugulose when dried.

Stipe dingy-grey, up to 4 cm. long, 8-12 mm. thick, stout, woody, equal, scabrid, central portion coarsely cellular; columella strongly thickened at the apex.

Gleba dark sepia-brown, almost black, cellular, cells minute, up to 0.5 mm. long, laterally compressed, dissepiments thin, whole context tough and resistant.

Spores smooth, sepia-coloured, ovate or less commonly elliptical, bluntly pointed at one end, rounded at the other, variable in size, 5-11 x 4-6 μ (Berkeley, 6-10 x 4-7 μ; Cleland, 8-9.5 x 6.5-7.5 μ), epispore thin.

Habitat.—Solitary on the ground.

Distribution.—Swan River, W. Aust. (Drummond. Type, in Herb. Kew), Monarto South, S.A. (J. B. Cleland, 27/5/21. Specimen in Herb. Cleland), Broken Hill, N.S.W. (A. Morris, Herb. Botanic Gardens, Sydney).

Characterised by the dark coloured spores, firm nature, almost black colour and very minute cells of the gleba. The peculiar woody stipe is also worthy of note. In the description given by Berkeley it is stated to be solid, but in the specimens I have examined there is a distinct central portion, extending from the base of the peridium to the base of the stipe, which is coarsely cellular. The cells of the gleba are extremely small and closely compacted together, and in certain parts numerous hyaline hyphae traverse them, giving the gleba a peculiar appearance under the low power.

The plant was first found by Drummond in 1844 in Western Australia on the bank of the Swan River. Until Dr. Cleland's specimens were obtained in 1921 no other collection had been made. I am indebted to Dr. Cleland for the loan of his specimens and for his donation of a specimen which is now in my herbarium, No. 1202. Also to Mr. Edwin Cheel for the loan of the specimen in his possession.

8. SECOTIUM AGARICOIDES (Czernajen) Hollos. (Text-fig. 10.)

Hollos, Gasteromycetes Hungariae, 1903.—*Endoptychum agaricoides* Czern., Bull. Soc. Imp. Nat. Moscou, xviii., 1845, p. 146, t. ii.-iv.—*Secotium acuminatum* Mont., Fl. Alg., vol. 1, 1845, p. 371, t. xxii. bis, f. 4.—*S. Thunii* Schulz, Verh. zool.-bot. Ges. Wien, vol., 15, 1865, p. 792.—*S. Szabolcsense* Hazlinsky, Mathem. et termes Zettudom Koslemenyek, vol. 13, 1875, p. 11.—*S. Warnei* Peck, Bull. Torr. Club, vol. 9, 1882, p. 2.—*S. pedunculatum* Lloyd, Myc. Notes, 1918, p. 788, f. 1183.

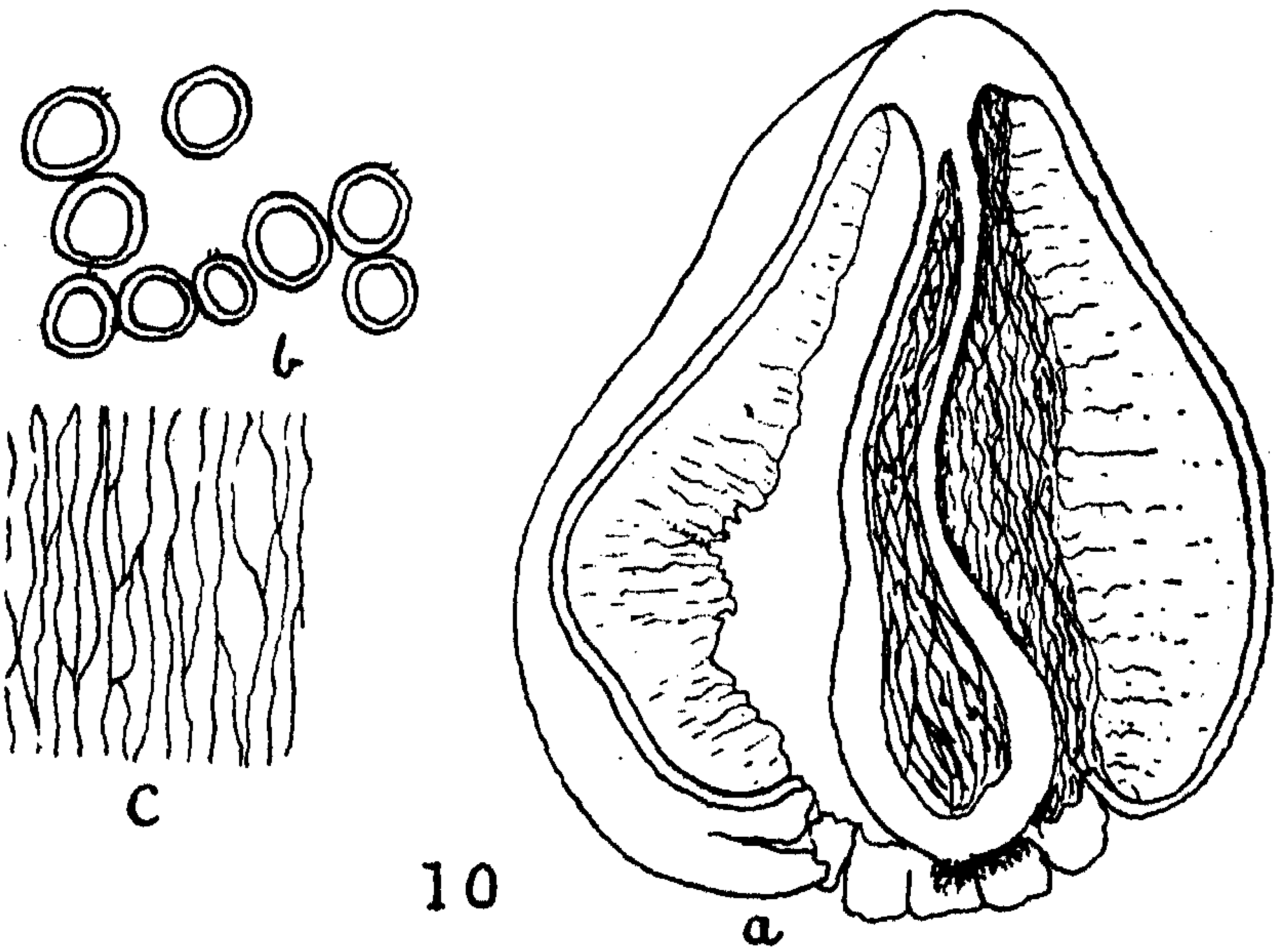
Sacc., Syll. Fung., vol. 7, 1888, p. 53; Cke., Hdbk. Aus. Fung., 1892, p.

220; Lloyd, Myc. Notes, 1903, p. 138, t. xiii., f. 1-11; 1916, f. 874; Conard, Mycologia, vol. 7, 1915, p. 104, t. clvii., f. 1-6.

Peridium dingy-grey, ovate, obtusely conical or subglobose, apex obtuse, base abruptly rounded or truncate, excavated, up to 8 cm. high and 5 cm. broad, minutely scabrid, and finely longitudinally striate, margin lacerate, often lobed.

Stipe very short, almost obsolete, dingy grey, scabrid, stuffed, up to 2 cm. long and 18 mm. wide at the base, where it is sometimes much inflated; columella thickened at the apex, free throughout.

Gleba dark bronze-brown, lamellate, lamellae sinuate, margins finely serrate, sparsely anastomosing, vertically arranged around the inner wall of the peridium.



Text-fig. 10. *S. agaricoides* (Czern.) Hollos. *a.* Plant (nat. size); *b.* spores (x 1000); *c.* lamellar gleba (x 2).

Spores smooth, ferruginous, globose or subglobose, 5-8 μ diam., sometimes shortly pedicellate; epispore thick.

Habitat.—Solitary on the ground in open grassy areas.

Distribution.—North America, Eastern Europe, Hungary, Russia, North Africa, Western Australia, New Zealand.

Western Australia: F. W. Stoward (*cf.* Lloyd, Myc. Notes, 1916, p. 617).

The illustrations and description are based on American specimens kindly donated by Dr. J. R. Weir, now in my herbarium, No. 1201.

The globose spores, bronze coloured, lamellate gleba and short, stout stipe characterise this species. It is an aberrant species, for the characters of the gleba and stipe are not typical of the genus as it is now understood.

The plant was first described in 1845 as *Endoptychum agaricoides* by Czernajen, from a plant collected in Ukraine; later, Montagne obtained a specimen from Algiers, which he named *S. acuminatum* (under which it is generally known); then in North America Peck obtained specimens which he named *Lycoperdon*

Warnei; later he changed the name to *Secotium Warnei*. *S. pedunculatum* was a name applied by Lloyd to a pedunculate form. I doubt whether such a minor character is sufficient to separate a species, especially in such a variable plant as this.

It has been recorded by Hollos from Australia (Banks Peninsula) [*sic*] and New Zealand; as I have not seen his paper I am unable to state where the plant was supposed to have been collected, or by whom.

9. SECOTIUM LEUCOCEPHALUM Massee. (Text-fig. 11.)

Mass., Grevillea, vol. 19, 1890, p. 95; Sacc., Syll. Fung., vol. 11, 1895, p. 157.

Peridium dingy-grey, depressed-globose, somewhat umbilicate, base truncate, excavated, 9-12 mm. high, 20-26 mm. wide, smooth, minutely longitudinally striate, glabrous, margin tardily separating from the stipe; drying pallid brown, surface becoming rugulose.

Stipe whitish, slender, 12-25 mm. long, 3-4 mm. thick, attenuate downwards, solid, striate, smooth, polished; columella expanded at the apex.

Gleba ferruginous, cellular, cells laterally compressed, up to 3 mm. long, dissepiments thin.

Spores verruculose, pallid ferruginous, ovate or ovate-elliptical, commonly lachrymiform, rounded at one end, pointed at the other, 9-11 x 5-7 μ (Massee, 8 x 5 μ), epispore thin.

Habitat.—Solitary on sandy soil.

Distribution.—Auckland, N.Z. (Berggren. Type, in Herb. Kew), Mt. Lofty, S. Aus. (J. B. Cleland, 4/8/22. Specimens in Herb. Cleland).

This species is characterised by the small, smooth, depressed-globose peridium and long, slender, *solid* stipe. The lachrymiform spores are also characteristic.

The Mt. Lofty collection is undoubtedly the same as the species described by Massee, as it agrees in all characters, save in the size of the spores. The difference in spore measurement is too slight to allow of the separation of these specimens. The solid stipe is a character present only in this and the following species. In shape the plant shows a general resemblance to *S. erythrocephalum*, but the pallid colour of the peridium, and the verruculose spores separate it.

I am indebted to Dr. Cleland for the loan of the material from which the above description has been drawn up.

10. SECOTIUM GUNNII Berkeley. (Text-fig. 12.)

Berk., in Herb.; Massee, Grevillea, vol. 19, 1890, p. 96; Sacc., Syll. Fung., vol. 11, 1895, p. 157; Cke., Hdbk. Aust. Fung., 1892, p. 221.

Peridium pallid brown, depressed-globose, base deeply excavated, truncate, 1.5 cm. diam., smooth; drying dingy-brown, rugulose.

Stipe short, 1-1.5 cm. long, 2-4 mm. thick, slender, equal, or slightly thickened downwards, solid, pallid-brown; columella expanded at the apex.

Gleba ferruginous, cellular, cells minutely polygonal, 1 mm. long, dissepiments thin.

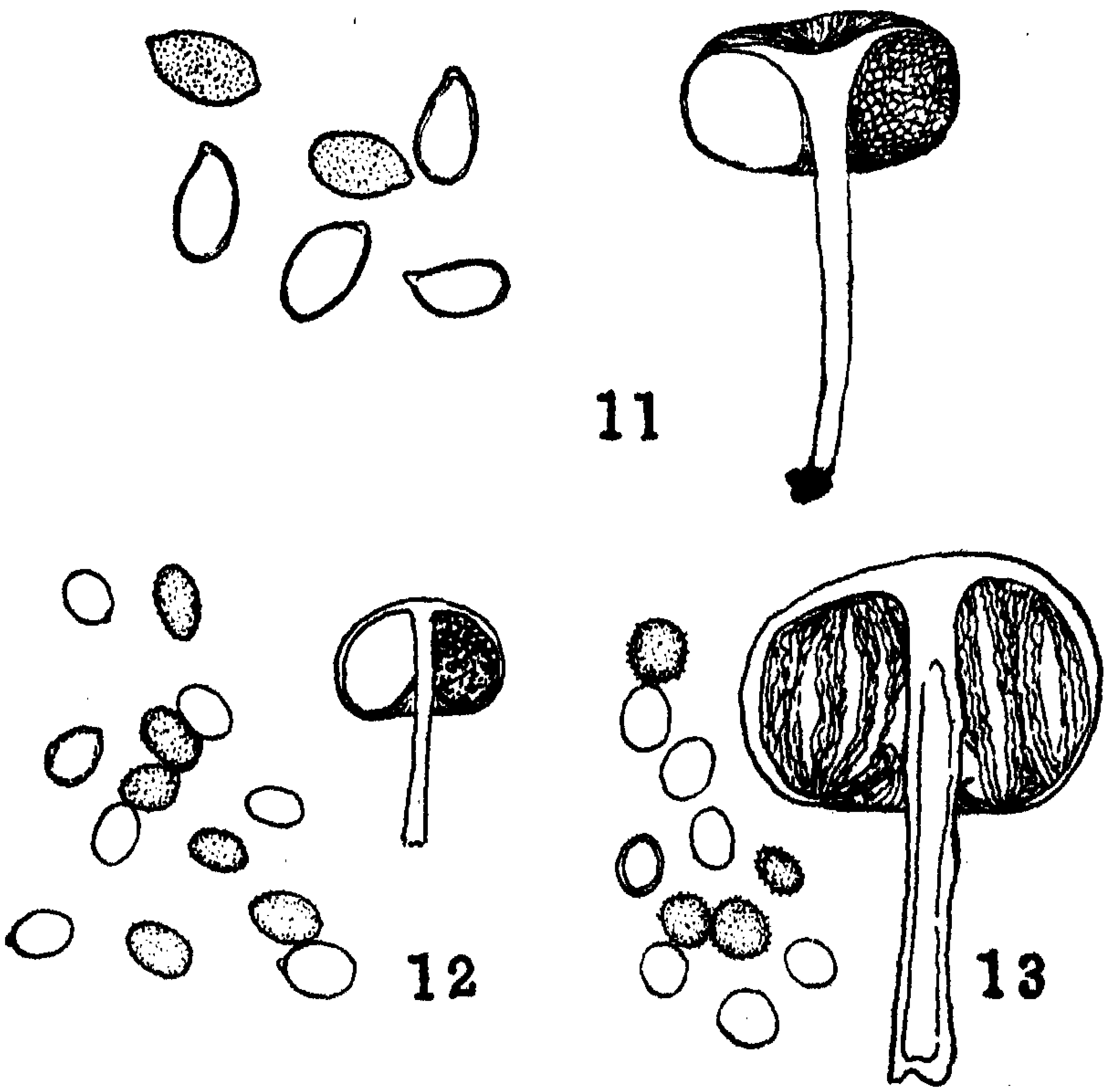
Spores minutely verruculose, broadly elliptical, pallid ferruginous, one end bluntly rounded, the other apiculate, 6-8 x 4-5 μ (Massee, 7 x 4 μ), epispore thin.

Habitat.—Solitary on the ground.

Distribution.—Sulphur Springs, Rotorua, N.Z. (Gunn. Type in Herb. Kew), Hobart (L. Rodway, Jan. 1884. Specimens in Herb. Rodway).

The smooth peridium, short, solid stipe and small, rough spores characterise this species. It is separated from the preceding principally on account of the short stipe and the small size of the spores.

In the original description the spores are stated to be smooth, but I find them to be minutely but distinctly verruculose. This character varies somewhat in individual plants, for, of the two plants in my possession, one exhibits more pronounced markings than does the other.



Text-fig. 11. *S. leucocephalum* Mass. Plant (nat. size); spores (x 1000).
Text-fig. 12. *S. Gunnii* Berk. Plant (nat. size); spores (x 1000).
Text-fig. 13. *S. Guinzii* Kunze. Plant (nat. size); spores (x 1000).

Lloyd (1905) states that he believes this to be a synonym of *S. coarctatum;* but examination will show that both in glebal and spore characters it is decidedly different.

I am indebted to Mr. Rodway for the donation of two specimens of this species, now in my herbarium, No. 1203. The question may be raised as to whether the material I have examined is that of *S. Gunnii*, but I am assured by Mr. Rodway that these specimens are from a collection determined by Massee himself.

11. SECOTIUM PORPHYREUM, n.sp. (Pl. xv., fig. 2; Text-fig. 14*b*.)

Peridio violaceo, depresso-globoso, 7 cm. alto, 7 cm. lato, leve, glabro. Stipite pallido-violaceo, 3-9 cm. longo, 10-20 mm. crasso, fibrilloso, striato, excavato. Gleba pallido-brunnea, cellulosa vel labyrinthiforma. Sporis grosse verruculosis, castaneo-brunneis, ovatis, 12-17 x 8-11 μ.

Hab.: Solitarii ad terram in silvis.

York Bay, Wellington, N.Z. 30 m., E. H. Atkinson.

Peridium violet, depressed-globose, base truncate, deeply excavated, up to 7 cm. high, and 7 cm. broad, smooth, glabrous, polished, viscid; drying pallid-brown, becoming rugulose.

Stipe pallid-violet, tinted yellow at the base, stout, 3-9 cm. long, 10-20 mm. wide at the base, tapering to the apex, fibrillose, minutely striate, hollow; columella slightly expanded at the apex.

Gleba pallid ferruginous, labyrinthiform or cellular, cells 1-2 mm. long, numerous, dissepiments thick.

Spores coarsely verruculose, chestnut-brown, ovate, one end rounded, the other pointed, 12-17 x 8-11 μ, epispore thin.

Habitat.—Solitary on the ground in beech forest. (*Nothofagus* sp.).

Distribution.—Beech Forest, York Bay, Wellington, N.Z. (E. H. Atkinson, 30 m., 5/10/10. Type, May, Aug., 1922; E. J. Butler, G.H.C., 29/7/23), Dun Mt., Nelson (J. C. Neill, 30/5/23). Collections in the herbarium of the writer. Nos. 873, 923, 1208.

This species is characterised by the large size and violet colour of the peridium. It is not uncommon in a certain beech forest near Wellington, appearing there during the winter months, usually after heavy rain. At first it is buried in the ground, often in clayey soil, but as it approaches maturity it appears on the surface. When submerged it is a pallid white, but as soon as it is exposed to the light it changes colour; that this change is effected by light is obvious when a specimen that has partially emerged is examined, for it is then seen that the portion above the ground is violet, but that the remainder is white. The peridium is decidedly viscid when fresh.

In its younger stages the plant is readily confused with *Gallacea scleroderma* (Cke.) Lloyd, as in colour and hypogeal habit it resembles this species; but when the peridium is sectioned the plants may be readily separated.

12. SECOTIUM GUINZII Kunze. (Text-fig. 13.)

Kunze, Flora, p. 322, 1840; Berk., Hook. Jour. Bot., vol. 2, 1843, p. 200; Sacc., Syll. Fung., vol. 7, 1888, p. 52; Cda., Icon. Fung., vol. 6, 1854, t. vi., f. 10-18.

Peridium depressed-globose or ovate, base excavated, up to 5 cm. diam., ochraceous, glabrous; drying ochraceous, becoming rugulose.

Stipe 3-5 cm. long, 8-12 mm. wide, equal, ochraceous, dull, pruinose.

Gleba ferruginous, lamellate, of closely compacted vertical plates, held together by interwoven hyphae.

Spores verruculose, subglobose, tinted yellow, 5-7 μ diam.

Habitat.—Solitary on the ground.

Distribution.—Cape of Good Hope, Tasmania (L. Rodway, Feb., 1923. Specimens in Herb. Rodway).

The above description is drawn up from a specimen kindly forwarded by Mr. Rodway, now in my herbarium, No. 1204. The species was determined for

Mr. Rodway by Mr. Lloyd. The above description does not agree well with that given by Saccardo, differing in the size and colour of the peridium, absence of "volva" from the base of the stipe, and colour and shape of the spores.

The peculiar nature of the gleba should characterise the Tasmanian plant; this consists of closely compacted plates arranged in a vertical manner around the columella, the whole apparently held compactly together by hyphae which pass from one plate to the other. Spores are not numerous—an unusual feature for a *Secotium*. I believe that the specimen at hand is parasitised by some Hyphomycete, for hyphae differing from the normal are abundant throughout the glebal tissues.

13. SECOTIUM PIRIFORME Cleland and Cunningham, n.sp. (Pl. xv., fig. 3; Text-fig. 15*a*.)

Peridio pallido-lilacino, depresso-globoso, vel piriformo, 12-16 mm. alto, 8-10 mm. lato, leve, glabro. Stipite griseo-albo, 5 mm. longo, 2-3 mm. crasso, leve, excavato. Gleba castaneo-brunnea, labyrinthiforma. Sporis grosse verruculosis, castaneo-brunneis, ellipticis vel liminiformis, apicibus acutis, 11-17 x 6-8 μ.

Hab.: Solitarii ad terram.

Somersby Falls, Gosford, N.S.W., G. P. Darnell-Smith.

Peridium pallid-lilac, depressed-globose, or commonly pyriform, 12-16 mm. high, 8-10 mm. wide, smooth, glabrous, polished, slightly viscid, attenuate downwards, margin continuous with the stipe; drying bay-brown, becoming rugulose.

Stipe pallid dingy-white, short, stout, 5 mm. long, 2-3 mm. wide, smooth, glabrous, hollow (or solid?), attenuate downwards, base somewhat inflated.

Gleba chestnut-brown, labyrinthiform, cells minute, irregular, up to 1 mm. long, numerous, dissepiments thin.

Spores coarsely verruculose, chestnut-brown, elliptical or commonly lemon-shaped, pointed at both ends, frequently pedicellate, 11-17 x 6-8 μ, epispore thin.

Habitat.—Solitary on sandy soil in damp places.

Distribution.—Somersby Falls, Gosford, N.S.W. (G. P. Darnell-Smith, 4/7/15, 27/6/16. Specimens in Herb. Cleland).

A further collection, obviously of the same species, but preserved in formalin, was forwarded by Dr. Cleland. This agrees with the above description, save that the spores are slightly larger.

When dried this species is about the size of a garden pea; it differs from all other Australasian species in that it possesses a "sterile base." This is in reality the base of the stipe to which the margin and base of the peridium are adherent, for in one specimen partial rupture may be observed (under the microscope) especially between the gleba and the stipe. I believe the specimens to be immature.

This species is characterised by the colour and small size of the peridium, together with its shape, and the glebal characters.

I am indebted to Dr. Cleland for the loan of the type material.

14. SECOTIUM CARTILAGINEUS, n.sp. (Pl. xviii., fig. 4; Text-fig. 15*b*.)

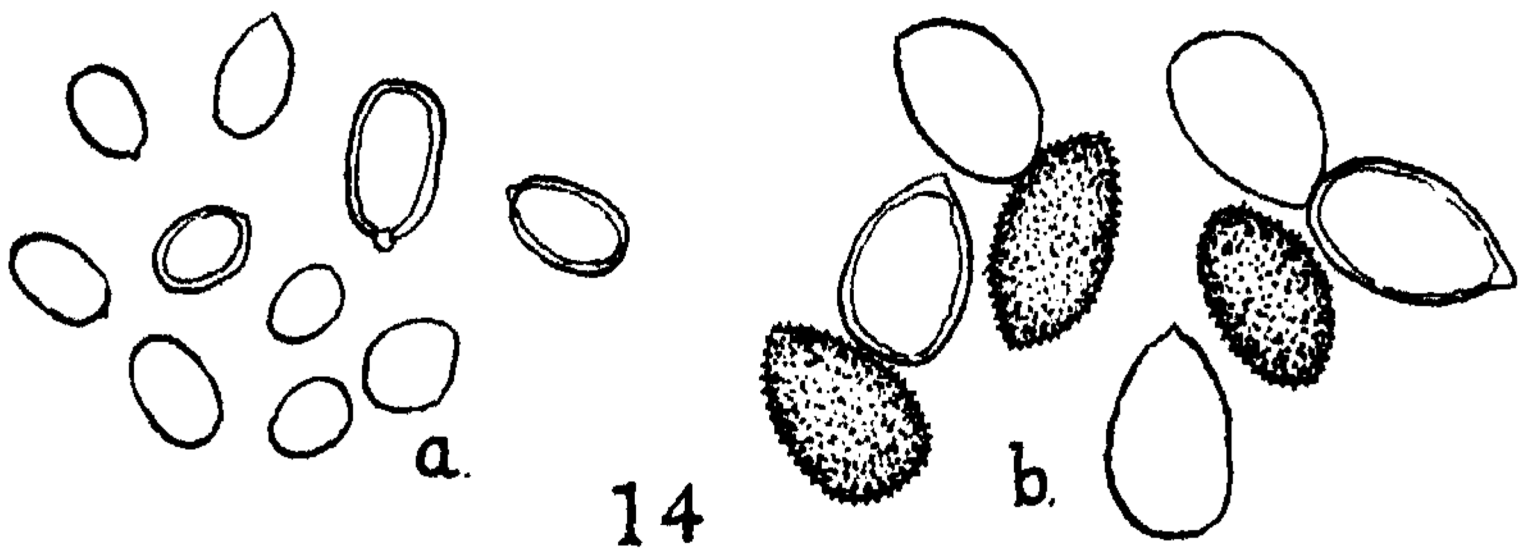
Peridio pallido-brunneo, depresso-globoso, base excavato, 7-12 mm. alto, 18-22 mm. lato, scabrido. Stipite 10 mm. longo, 4 mm. crasso, brunneo, excavato. Gleba aurantio-brunnea, cellulosa, lenta. Sporis verruculosis, flavo-brunneis, ovatis, 12-15 x 8-11 μ.

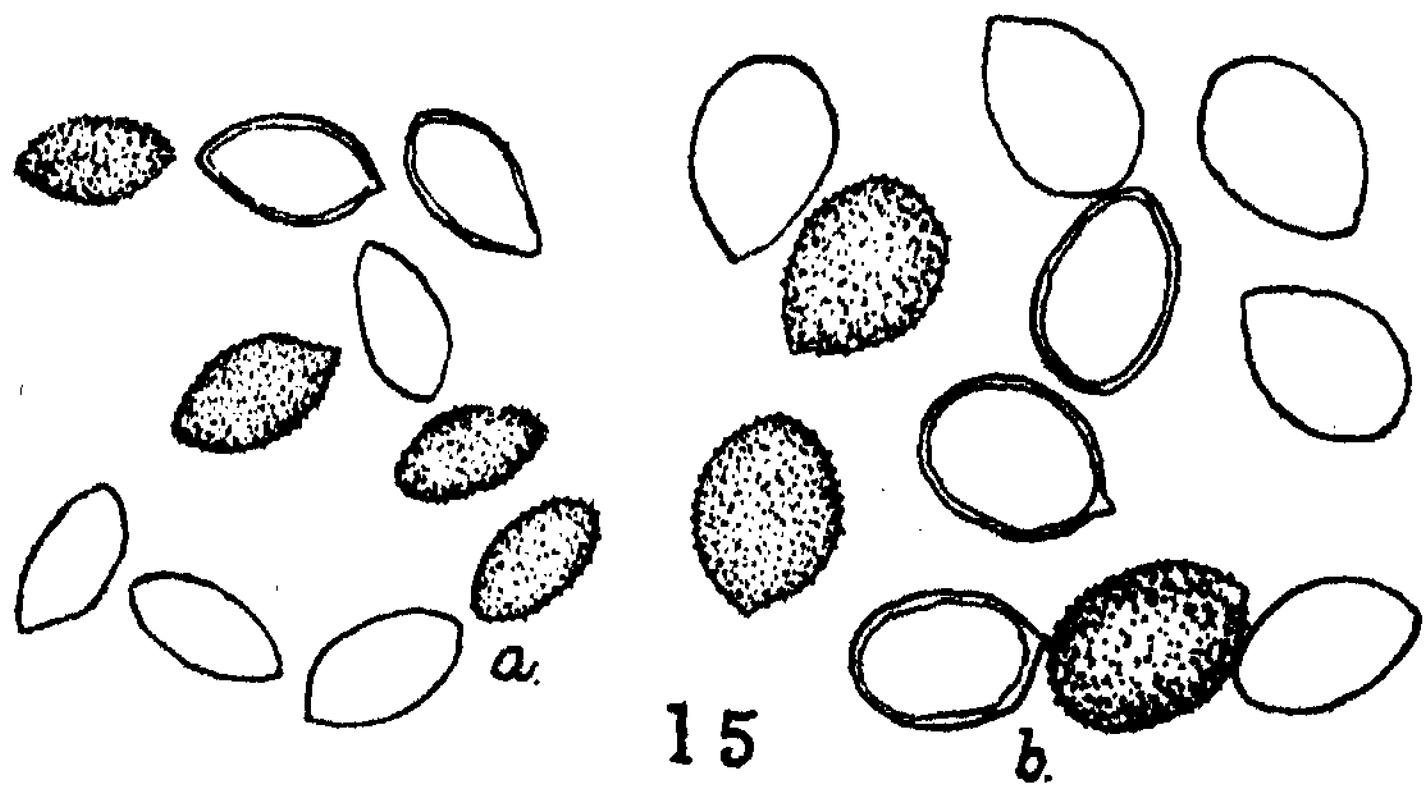
Hab.: *Solitarii ad terram in silvis.*

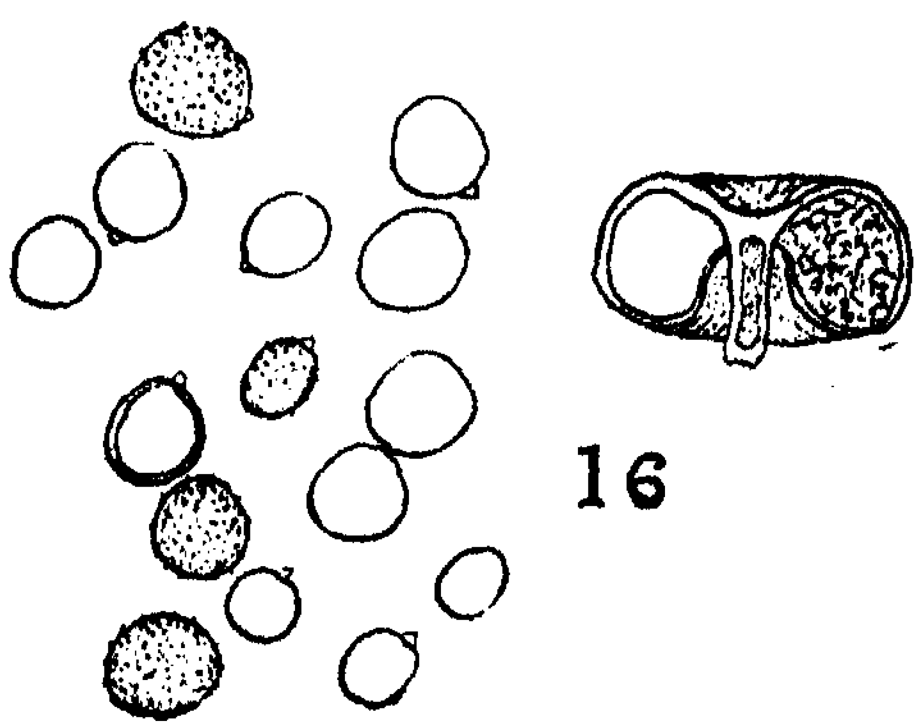
Dun Mt., Nelson, N.Z., 650 m., J. C. Neill.

Peridium pallid-tan, paler below, depressed-globose, base excavated, incurved, margin distinct from stipe, 7-12 mm. high, 18-22 mm. wide, densely and closely scabrid; drying dingy-brown.

Stipe short, stout, up to 10 mm. long, 4 mm. thick, tan-coloured, hollow, scabrous, base slightly inflated.







Text-fig. 14. *a.* Spores of *S. melanosporum* Berk. (x 1000); *b.* Spores of *S. porphyreum* G. H. Cunn. (x 1000).

Text-fig. 15. *a.* Spores of *S. piriforme* Clel. et Cunn. (x 1000); *b.* spores of *S. cartilagineus* G. H. Cunn. (x 1000).

Text-fig. 16. *S. Rodwayi* Mass. Plant (nat. size); spores (x 1000).

Gleba dark ferruginous, cellular, tough, compact, cells minute, 2-3 mm long, polygonal, dissepiments thin.

Spores verruculose, ferruginous, ovate, rounded at one end, pointed at the other, 12-15 x 8-11 μ, epispore thin.

Habitat.—Solitary on the ground in beech forest.

Distribution.—Beech Forest, Dun Mt., Nelson, N.Z., 650 m. (J. C. Neill), 27/5/23. Type in herbarium of the writer, No. 1099).

The scabrid surface of the peridium would place this close to *S. scabrosum*, but the glebal characters are different from those given for the latter species.

In appearance and to the touch the peridium exactly resembles chamois leather. The tough, almost cartilaginous nature of the gleba is also characteristic, and would serve to separate it from any other Australasian species.

15. SECOTIUM RODWAYI Massee. (Text-fig. 16.)

Mass., Kew Bulletin, 1901, p. 158; Sacc., Syll. Fung., vol. 17, 1901, p. 218.

Peridium ochraceous-white, depressed-globose, umbilicate, base deeply excavated, 2-3 cm. diam., tomentose; drying dingy-brown, becoming rugulose.

Stipe hardly apparent, 3 x 2 mm., subequal, hollow, tomentose.

Gleba pallid-ochraceous, labyrinthiform, cells minute, 1 mm. long, dissepiments thin.

Spores verruculose, hyaline, globose or subglobose, apiculate, 6-9 μ (Massee, 7-8 μ), epispore thin.

Habitat.—Hypogean, solitary in sandy soil.

Distribution.—Tasmania. (L. Rodway, June, 1898. Type, in Herb. Kew).

The small size, shape and colour of the spores separate this from any other species possessing a rough peridium. Massee states that the species is subterranean, and specimens are exposed only when washed out by rain or dug out by small marsupials.

I am indebted to Mr. Rodway for co-type material from which the above description has been drawn up. These are now in my herbarium, No. 1205.

16. SECOTIUM SCABROSUM Cooke and Massee.

Cke. et Mass., Grev., vol. 20, 1891, p. 35; Cke., Hdbk. Aust. Fungi, 1892, p. 221; Sacc., Syll. Fung., vol. 11, 1895, p. 57.

Peridium dingy-olive, or greyish, depressed-globose, 2 cm. diam., minutely scabrid.

Stipe short, almost obsolete.

Gleba dark reddish-brown, lacunose, septa gill-like, warted and folded.

Spores rather coarsely warted, lemon-shaped, pallid olive-yellow, 16-18 x 10 μ.

Habitat.—Solitary on the ground.

Distribution.—Domain, Melbourne (Mueller. Type in Herb. Kew).

I have not seen specimens; the above description is that of the original.

The species should be readily determined on account of the lamellar gleba. Strangely enough, this is the only record of the occurrence of this genus in the State of Victoria.

EXCLUDED SPECIES.

a. *Secotium Drummondii* Berkeley, *in Herb.*

This has by Massee been used as the type of his genus *Chainoderma* Mass. (Grev., vol. 19, 1890, p. 46).

b. *Secotium excavatum* Kalchbrenner.

Hennings has placed this in the genus *Strobilomyces* (Boletinae) as *S. excavatum* P. Henn. (Hedw., vol. 43, 1904, p. 187).

c. *Secotium lilacense* Berkeley, Hdbk. N.Z. Flora, 1867, p. 617.

As the description of this species was drawn up from a water colour drawing, and not from a specimen, it has no place in botanical literature. The description given by Berkeley is such that if the plant should be encountered the finder would have some difficulty in determining it!

"Azure, brief, pallid, fibrose, pruinose; pileus subglobose, lilac, spotted, 12 mm. high.

Hab.: On wood, Central N.Z., Haast.

d. *Secotium sessile* Mass. et Rodw. *Nomen nudum.*

Dr. Butler, Bureau of Mycology, Kew, informs the writer * that Mr. Mason of the Bureau has searched for but has been unable to find any published description of this plant. He states that there is a collection at Kew Herb., labelled "Tasmania, Rodway, 647, Type."

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EXPLANATION OF PLATES XII.-XV.

Plate xii.

1. Developmental stage of *S. novae-zelandiae* G. H. Cunn. (x 45). First appearance of radial cavity in primordium of the gleba. Note parallel arrangement of the hyphae of the stipe. The striae across the surface are caused by gaps in the microtome knife.

2. Later stage; the wedge-shaped area of the partial veil has become well defined. (x 35).

*Letter to writer, 25/10/23.

3. Stage showing first appearance of the cavity of the stipe, and downgrowth of tramal plates from the roof of the first glebal cavity. Note the abundant spores, well-marked partial veil and parallel arrangement of the hyphae of the stipe. (x 25).

4. Appearance of lacunae in the undifferentiated portion of the gleba (top, left). (x 15).

5. Further differentiation of the gleba. (x 8).

Plate xiii.

1. Stage showing the appearance of lacunae in the tramal plates in *S. novae-zelandiae*. (x 8).

2. *S. erythrocephalum* Tul. (nat. size).

3. *S. novae-zelandiae* G. H. Cunn(nat. size). Section on left. Photograph from water colour painting by E. H. Atkinson.

Plate xiv.

1. Section through nearly mature plant of *S. erythrocephalum* Tul. (not quite median). (x 4). *p.*, peridium; *gl.*, gleba; *col.*, columella; *st.*, stipe. The perforations in the columella are due to insects.

2. *S. superbum* G. H. Cunn. (x ½).

Plate xv.

1. *S. melanosporum* Berk. (nat. size). Note coarsely cellular stipe.

2. *S. porphyreum* G. H. Cunn. (Nat. size). Note that although the gleba is removed from the stipe it is nevertheless covered with remnants of the partial veil.

3. *S. piriforme* Clel. et Cunn. (nat. size). (Formalin specimens photographed in solution of formalin).

4. *S. cartilagineus* G. H. Cunn. (nat size).

Corrigenda.

Page 104, line 7 from bottom *for* locis gramineis *read* sylvis

Page 105, line 7 *delete* in grassy places; lines 9, 10 *read* Forest Reserve, Paekakariki, Whakatikei

Page 108, line 8 from bottom, and page 110, line 10, *for* Cleland *read* Cleland and Cheel

A MONOGRAPH OF THE FRESHWATER ENTOMOSTRACA OF NEW SOUTH WALES. PART IV. PHYLLOPODA.

By MARGUERITE HENRY, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Plates xxviii.-xxxii.)

[Read 30th April, 1924.]

Introduction.

The first Phyllopod to be recorded in Australia was *Lepidurus viridis*, which Baird described in 1850 from a specimen collected in Tasmania. The next records are those of the Rev. R. L. King published in 1855; King, very briefly, described four species from New South Wales, some of which were not even figured. This lack of figures hampered later writers in their identification of the species and some synonymy resulted; in King's original manuscript, all of which was not published, there are detailed figures of all the species and from these the author has been able to decide some doubtful points of synonymy.

In 1860 and 1866 Baird described two species collected in South Australia, one of which was synonymous with his *Lepidurus viridis*.

Claus redescribed one of King's species in 1872 from immature specimens.

In 1876 Richters described a new species which he called *Branchipus australiensis* from Peak Downs, Queensland.

In 1877 Tate described a *Lepidurus* collected in South Australia which was also synonymous with *L. viridis*.

Four new species of Conchostraca from South Australia were described by Brady in 1886, one of which was synonymous with one of King's species.

In 1887 Sars described *Cyclestheria hislopi* (Baird) as the type of a new genus; the specimens had been hatched from dried mud collected at Rockhampton, Queensland.

Eight species of Phyllopoda were recorded in Whitelegge's list of the Invertebrate Fauna of Port Jackson and the neighbourhood, which was published in 1889.

In 1895 Spencer and Hall gave a preliminary description of *Apus australiensis* from Central Australia, and Sars published a paper describing five of the previously described species. This was a valuable contribution to the literature of Australian Phyllopoda, since it contained very detailed descriptions, biological observations and five plates.

In 1896 the Report of the Horn Expedition to Central Australia was published, in which Spencer and Hall described four new species and proposed the

new genus *Limnadopsis*. The same year Sars published three papers, one dealing with two Phyllopoda from Western Australia, the second describing two new species from Queensland and the third tracing the development of *Estheria packardi*.

In 1902 Sayce gave a complete catalogue of the Australian Phyllopoda that had been previously recorded; he described some of the older species in more detail and six new species; he also proposed two new genera, *Parartemia* and *Branchinella*.

The Phyllopoda collected by the South Australian Museum Expedition to Strzelecki and Cooper Creeks were dealt with by Chilton in 1917.

At the present time eighteen species have been recorded from South Australia, including Central Australia and the Northern Territory; eight species from Victoria; six from Queensland; four from Western Australia and one from Tasmania. The present paper deals with nineteen species collected in New South Wales; six of these are described as new and three others are recorded for the first time in the State, and one for the first time in Australia.

The author's thanks are due to Dr. C. Anderson for permission to examine the collection of Phyllopoda in the Australian Museum and to Mr. F. McNeill for his ever ready help in facilitating their study. The whereabouts of King's original manuscript was traced by Mr. G. M. Goldfinch and Professor Mackie kindly lent it to the author from the library of the Teachers' Training College.

The author is especially indebted to Sir Baldwin Spencer and Dr. C. Chilton for specimens collected in Central Australia; to Professor T. Harvey Johnston for a collection from the Burnett River, Queensland; to Professor L. Harrison for specimens collected in various parts of New South Wales and to Sir T. W. Edgeworth David for a sample of dried mud from which a specimen of *Artemia salina* was obtained.

The drawings for this paper were all prepared by Miss D. Harrison.

Type specimens of the new species have been deposited in the Australian Museum, Sydney.

The following lists give the species of Phyllopoda recorded from the different States.

New South Wales.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae*.—*Artemia salina* (Linn.) var. *arietina* Fischer.

Subfamily *Branchinectinae*.—*Branchinecta tenuis*, n.sp., *B. parooensis*, n.sp.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae*.—*Branchinella australiensis* (Richters), *B. frondosa*, n.sp., *B. proboscida*, n.sp., *Branchinella eyrensis* Sayce, *Branchinella ornata* (Wolf).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Limnadopsis birchii* (Baird), *L. parvispinus*, n.sp., *Paralimnadia stanleyana* (King), *Eulimnadia sordida* (King), *Estheria packardi* Brady, *E. lutraria* Brady, *E. rubra*, n.sp.

Family LIMNETIDAE.—*Limnetis macleayana* King, *L. tatei* Brady.

Victoria.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.*—*Branchinella australiensis* (Richters).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia sordida* (King), *E. victoriensis* Sayce, *Estheria packardi* Brady.

Family LIMNETIDAE.—*Limnetis macleayana* King, *L. tatei* Brady.

South Australia.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae.*—*Artemia salina* (Linn.) var. *arietina* Fischer.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.*—*Branchinella australiensis* (Richters), *B. eyrensis* Sayce.

Family BRANCHIPODIDAE.

Subfamily *Parartemiinae.*—*Parartemia zieziana* Sayce.

Family STREPTOCEPHALIDAE.—*Streptocephalus archeri* Sars.

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia dahli* Sars, *E. sordida* King, *Limnadopsis birchii* (Baird), *L. tatei* Spencer and Hall, *L. brunneus* Spencer and Hall, *Estheria packardi* Brady, *E. lutraria* Brady, *E. dictyon* Spencer and Hall.

Family LIMNETIDAE.—*Limnetis macleayana* King, *Limnetis tatei* Brady, *Limnetis eremia* Spencer and Hall.

Queensland.

NOTOSTRACA.

Family APODIDAE.—*Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family STREPTOCEPHALIDAE.—*Streptocephalus archeri* Sars.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.*—*Branchinella australiensis* (Richters).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia dahli* Sars, *Cyclestheria hislopi* Sars.

Western Australia.

NOTOSTRACA.

Family APODIDAE.—*Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae.*—*Artemia salina* (Linn.) var. *arietina* Fischer.

CONCHOSTRACA.

Family LIMNADIIDAE.—*Estheria elliptica* Sars, *E. sarsii* Sayce.

Tasmania.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird.

Classification.

The Phyllopoda are divided into three suborders, the Anostraca, Notostraca and Conchostraca, and this classification has been followed in the present paper. Some writers reject the term Phyllopoda and divide the subclass Branchiopoda into four orders; Anostraca, Notostraca, Conchostraca and Cladocera.

Key to the suborders of Phyllopoda.

A. Body elongated, devoid of a carapace .. .. *Anostraca.*
AA. Body with a well developed carapace.
B. Carapace in the form of a shield covering the dorsal part of the body. *Notostraca.*
BB. Carapace composed of two two lateral valves which enclose the body. *Conchostraca.*

Suborder **Notostraca.**

Carapace shield-shaped, covering the dorsal part of the body. Second antennae reduced or absent. Eyes sessile. Caudal filaments jointed.

This suborder comprises a single family, the *Apodidae*, which has a world-wide distribution.

Family APODIDAE.

Carapace broad, with a cervical furrow defining the head. A variable number of segments projecting beyond the carapace. Caudal filaments elongated. Males without special clasping organs.

This family comprises two genera, both of which are represented in New South Wales.

Key to the genera of the Apodidae.

A. Last caudal segment produced into a flattened outgrowth between the caudal filaments .. .. *Lepidurus.*
AA. Last caudal segment not produced .. .. *Apus.*

Genus LEPIDURUS Leach, 1816.

Carapace large, usually covering all the body except one or two segments. Last caudal segment produced into a flat paddle-shaped outgrowth, extending between the caudal filaments. About sixty-three pairs of legs, the first pair with comparatively short endites which scarcely project beyond the edge of the carapace. Species very variable; fifteen have been described, one of which occurs in New South Wales.

LEPIDURUS VIRIDIS Baird.

Baird, Proc. Zool. Soc. London, 1850.

Syn.—*L. angasii* Baird, *L. viridulus* Tate, *L. kirkii* Thomson, *L. compressus* Thomson.

A detailed description and numerous figures are given by Sars (Archiv. for Math. og Nat., 1895, p. 4, Pl. 1, figs. 1-19). This is a very variable species, especially in the comparative length of the carapace. Specimens from five different localities were examined at the Australian Museum and the following measurements obtained: 1. Specimens from Deniliquin had an average length of 38 mm. and the carapace left four segments uncovered. 2. A single specimen from Hay was 32 mm. long and had 10 segments exposed. 3. Two specimens from Tamworth, one 20 mm. long and the other 25 mm., the former had 6 exposed segments and the latter 4. 4. A specimen labelled N.S.W. was 15 mm.

long and had 10 segments exposed. 5. A specimen from Molong was 25 mm. long and only the caudal segment was exposed.

Two specimens collected at Holbrook measured only 6 mm. in length and were possibly immature, so that the species could not be identified with certainty. The specimens were remarkable: carapace very long, covering all the body and also the caudal prolongation; dorsal keel distinct, extending more than three-quarters the length of the body, produced backwards into a long spine; carapace also produced back into spines at each side, the margins between the spines bearing a series of strong denticles; caudal prolongation broad at the base, somewhat triangular in form, bearing well-marked spines.

Distribution.—N.S.W.: Sydney, Hay, Tamworth, Molong, Deniliquin, Holbrook (?), Hunter River. Victoria; South Australia; Tasmania; New Zealand.

Genus Apus Schaeffer, 1756.

Carapace usually comparatively shorter than in *Lepidurus*. Telson short, cylindrical, without any paddle-shaped outgrowth. Endites of the first pair of legs usually much longer than in *Lepidurus*.

Thirty different species have been described; one occurs in New South Wales.

The genera *Apus* and *Lepidurus* are very closely allied and it may be questioned whether they are distinct; the main difference is the presence or absence of a caudal outgrowth, but this in itself seems insufficient for the separation into two genera. The comparative length of the endites of the first pair of legs and the relative amount of body covered by the carapace are not good generic characters and vary greatly even in members of the one species.

Apus australiensis Spencer and Hall.

Victorian Naturalist, xi., 1895, p. 161; Horn Expedition to Central Australia, Part ii., Zoology, 1896, p. 231, figs. 1-3.

This is a very variable species; specimens from the same locality often varying greatly in their relative dimensions. In 1896 Sars (p. 5, Plate 1, figs. 1-6) described a specimen from Western Australia with the following measurements: Total length 13 mm., length of carapace 8.5 mm., median length of carapace 6.5 mm., width of carapace 5.8 mm., length of caudal filaments 7.4 mm., length of exposed portion of the body 6.4 mm., length of terminal caudal segment 0.7 mm. The most striking differences between these measurements and those of Spencer and Hall are: 1. the carapace is longer in proportion to the exposed part of the body instead of being of equal length; 2. the width of the carapace does not attain its median length instead of exceeding it. Measurements were made of nine mature specimens, collected at Broken Hill, for comparison with these two sets of figures and the following table shows the variations in comparative proportions. In eight specimens the width of the carapace was greater than its median length and in all nine specimens the length of the carapace was greater than the length of the exposed portion of the body.

This species also varies in the number of exposed segments, the armature of the posterior sinus of the carapace and of the caudal segment, and the presence or absence of serrations on the lateral margins of the carapace. These variations are well marked in specimens in the Australian Museum which have been collected from different localities:

Measurements of Specimens from Broken Hill.

Specimen	1	2	3	4	5	6	7	8	9
Total length	50	42	45	50	38	27	42	40	43
Length carapace	30	23	27	28	25	20	25	24	25
Median length carapace	22	20	22	24	21	16	20	20.5	21
Width carapace	26	25	25	25	21	20	26	24	26
Length exposed portion of the body	20	19	18	22	13	7	17	16	18
Length terminal caudal segment	3	2	2	2	2	1	2	2	1.5
Width of same	4	3.5	3.5	3	3	2	3	3	3.5
Length caudal filament	—	8	21	11	15	12	21	10	26

1. Specimen from the Namoi River at Narrabri. Total length 30 mm., carapace 4 mm. shorter than the exposed portion of the body; median length equalling the width; 32 exposed segments, of which 14 are limbless. Posterior sinus with over 30 small denticles. No serrations present on the lateral margin of the carapace.

2. Locality Ivanhoe. Total length 45 mm., carapace 5 mm. longer than the exposed portion; median length equal to the width; 28 exposed segments, 12 being limbless. Posterior sinus bearing 30 spines. Lateral margins of the carapace minutely serrated for half their length.

3. Locality Bourke. Total length 38 mm.; carapace 6 mm. shorter than the exposed portion; width exceeding the median length by 2 mm.; 28 exposed segments. Posterior sinus with 33 spines. Lateral margins of the carapace minutely serrated in the lower part. In one specimen, caudal segment devoid of spines; in a second, the segment with two central spines, one above the other; in a third specimen, the segment without central spines but with a small group on each side.

4. Locality Mossgiel. Total length 55 mm.; carapace and exposed portion of the body of equal length; width exceeding the median length by 7 mm.; 28 exposed segments, 12 being limbless. Posterior sinus with 37 spines; a few minute spines on each side of the carapace. Caudal segment with a group of three spines and a sensory bristle on each side, a row of three spines down the centre and a row on the posterior edge.

In the living animal the colours are very striking. The carapace is yellowish-brown with deeper brown markings and changing opalescent tints; the exposed portion is yellowish-green, the spines usually being dark brown; the legs are reddish-brown.

Distribution.—N.S.W.: Hunter River, Macquarie River, Mossgiel, Narrabri, Ivanhoe, Bourke, Nyngan, Broken Hill, Budda and Marra Stations (Darling River), Goorimpa (Paroo River). Queensland; Victoria; Central Australia; South Australia; Western Australia.

Suborder **Anostraca.**

Body elongated, without a carapace, more or less vermiform, composed of 11-19 limb-bearing segments and 8 or 9 limbless segments. Eyes stalked and movable. Antennules small, filiform. Antennae in the male modified for clasping. Daday de Dees in his excellent monograph of the Anostraca (1910) has divided the suborder into five families, two of which are represented in New South Wales. Daday de Dees' scheme of classification has been followed through-

out. For convenience the pedigerous portion of the body has been termed the "trunk" and the limbless portion the "abdomen."

Key to the Families of the Anostraca.

A. 17 or 19 trunk segments, antenna of the ♂ one-segmented .. .. *Polyartemiidae.*
AA. 11 trunk segments, antenna of the ♂ 2- or 3-segmented
 B. Antenna of the ♂ 3-segmented .. .. *Streptocephalidae.*
 BB. Antenna of the ♂ 2-segmented.
  C. Basal segments of the male antennae joined, forming with the head a frontal clypeus .. .. *Branchipodidae.*
  CC. Basal segments of the male antennae not joined or very slightly joined at the base.
   D. Head, male, with forehead unarmed .. .. *Branchinectidae.*
   DD. Head, male, with one or more frontal appendages .. .. *Chirocephalidae.*

Family BRANCHINECTIDAE.

Body of variable dimensions; trunk either equal to the length of the abdomen without the cercopods, slightly longer or much shorter. Trunk composed of 11 segments, abdomen of 8 or 9. Cercopods of varying length, either mobile, articulating with the last segment of the abdomen or immobile. Head of both male and female unarmed. Antennae of the male composed of two segments, apical segment flattened or falciform. Apical segment of the penis usually denticulate, rarely smooth.

Key to sub-families of the Branchinectidae.

A. Abdomen composed of 8 segments, apical segment of antennae in the male flattened .. .. *Artemiinae.*
AA. Abdomen composed of 9 segments, apical segment of antennae in the male often triangular, falciform .. .. *Branchinectinae.*

Subfamily ARTEMIINAE Daday de Dees.

Body slender. Abdomen composed of 8 segments, the last of which is longer than the preceding segments. Cercopods short, of diverse form and structure. Head in both sexes simply rounded. All legs of similar structure, with one leaf-like branch. Apical segment of the penis usually with a spinulose surface, unarmed at the apex. This subfamily includes two genera which are inhabitants of fresh, brackish and salt water. One genus is represented in New South Wales.

Genus ARTEMIA Leach, 1819.

Male antennae with the basal segments slightly joined at the base; apical segments flattened, elongated, with the apex pointed. Egg-sac short, heart-shaped. Species very variable. One species occurs in New South Wales.

ARTEMIA SALINA (Linnaeus) var. ARIETINA Fischer.

Syn.—*Branchipus arietinus* Grube, *Branchipus oudneyi* Liévin, *Artemia proxima* King, *Artemia australis* Sayce, *Artemia westraliensis* Sayce.

Artemia salina is a very variable species and its synonymy is accordingly somewhat confused. There are, however, four distinct varieties, and the three forms described from Australia are all comprised in the variety *arietina* Fischer. The first of these was described by King in 1855 (p. 70) as *Artemia proxima*; the description was very brief and the only figure published was that of the

fifth leg, so that its identification was uncertain. In King's original manuscript, however, there is a page of drawings which include figures of the whole animal and separate studies of its parts; these show that it is decidedly synonymous with *A. salina*. In 1902 (p. 229) Sayce described two forms under the names of *A. australis* and *A. westraliensis* which are also synonymous.

The variety is characterised by its immobile cercopods which are united with the last segment of the abdomen, their form is variable, they are usually flattened and leaf-like, they may be poorly supplied with apical setae or both apical and lateral setae may be numerous. The body is of variable dimensions, the length of the trunk may be greater or less than that of the abdomen; the last segment of the abdomen may be longer than the preceding segments or of equal length. Egg-sac variable.

Distribution.—King's specimens were collected in salt-pans at Newington, N.S.W. A single female specimen was bred from dried mud collected at Macumba, Central Australia. Sayce's specimens were obtained from Glenelg, South Australia and Murchison, Western Australia.

Europe; Asia; Africa; North America.

Subfamily BRANCHINECTINAE.

Body of varying dimensions, the trunk often not attaining the length of the abdomen without the cercopods. Abdomen composed of 9 segments, last segment much shorter than the preceding segments. Cercopods usually mobile, rarely immobile and joined to the last segment of the abdomen. Antennae of the male two-segmented, apical segment either falciform or branched. Head of both male and female, rounded, unarmed.

This subfamily includes three genera which live in fresh and salt water.

Key to genera of Branchinectinae.

A. Cercopods mobile, articulating with the last segment of the abdomen.
  B. Apical segments of the male antennae falciform, simple .. .. *Branchinecta.*
  BB. Apical segments of the male antennae branched .. .. *Artemiopsis.*
AA. Cercopods immobile, united with the last segment of the abdomen .. .. *Branchinectella.*

Genus BRANCHINECTA Verrill, 1869.

Body of varying dimensions, either slender or very robust. Trunk usually not as long as the abdomen without the cercopods. Abdomen composed of 9 segments, the last of which is often tapering, rarely of uniform breadth, always much shorter than the preceding segments. Cercopods mobile. Integument of the body smooth. Head rounded, unarmed. Antennules filiform, varying in length. Antennae in the male with the basal segments either unarmed or with tubercles and setae, apical segments usually falciform. Antennae in the female flattened. Egg-sac variable.

Key to species of Branchinecta.

A. Antennules reaching the end of the first segment of the antenna .. .. . *tenuis.*
AA. Antennules far exceeding the length of the whole antenna .. .. .. *parooensis.*

BRANCHINECTA TENUIS, n.sp. (Plate xxx., figs. 4-7.)

Male (Fig. 4). Body long and slender. Trunk slightly longer than the abdomen without the cercopods. All segments of the body with a smooth surface, unarmed, last segment of the abdomen very short, less than half the length of

the preceding segments. Cercopods (Fig. 6) very long, equalling the last five segments of the abdomen combined, broad at the base, tapering to the apex, both margins bearing long setae. Head rounded, unarmed. Antennules narrow, slender, reaching the end of the first segment of the antenna. Basal segment of the antenna (Fig. 5) broad, inner margin bearing three leaf-like projections, middle projection serrated; second segment curved back over the first, tapering towards the apex, inner margin bearing a double row of denticles. Eyes of moderate size. Legs (Fig. 7) all of similar structure. Length 12 mm.

Female. Similar to the male in general structure of the body. Antennules slender, not quite as long as the antennae. Antennae flattened, leaf-like, pointed at the apex, surface bearing scattered hairs. Egg-sac very long and slender. Colour of spirit specimens milky white.

Distribution.—N.S.W.: Dubbo.

BRANCHINECTA PAROOENSIS, n.sp. (Plate xxxi.)

Male. Body very robust, trunk not quite as long as the abdomen without the cercopods. Segments smooth and polished, in places bearing very minute hairs. Last segment of the abdomen much shorter than the preceding segments, tapering slightly posteriorly. Cercopods equal in length to the last four segments combined, strongly built and densely fringed with setae on both margins. Head comparatively small, forehead rounded, no trace of any frontal process. Eye small. Antennules unusually long, extending to about the ninth trunk segment, strongly built, tapering gradually to the apex. Antennae composed of two segments, basal segment broad and bearing an outwardly directed process which is minutely spinulate; second segment curved, strongly built, margins bearing tiny spines. Legs of similar structure. Length 36 mm.

Female. Similar to the male in general build, slightly smaller. Antennae flattened, pointed at the apex.

Colour in living specimens, transparent, cercopods faintly tinged with pink. Spirit specimens opaque white.

Distribution.—Clay pans on Goorimpa Station, Paroo River.

Family CHIROCEPHALIDAE.

Body of varying dimensions, trunk either attaining the length of the abdomen without the cercopods or longer than it. Trunk composed of 11 segments, abdomen of nine, last segment of the abdomen shorter than the preceding ones. Cercopods mobile, articulating with the last segment of the abdomen, rarely joined. Head of the female rounded, unarmed, that of the male either unarmed or with frontal appendages of varying structure. Basal segments of male antennae variously armed or unarmed. Eleven pairs of legs, rarely dissimilar. Apical segment of the penis either spinulose or with a smooth surface and pointed apex. Daday de Dees divides this family into three subfamilies, one of which is represented in New South Wales.

Key to subfamilies of Chirocephalidae.

A. Apical segment of the penis smooth, pointed terminally.
  B. Antennae of the male with serrated appendages .. .. .. *Chirocephalinae.*
  BB. Antennae of the male lacking serrated appendages .. .. *Eubranchipodinae.*
AA. Apical segment of the penis spinulose .. .. *Branchinellinae.*

Subfamily BRANCHINELLINAE.

Body of varying dimensions. Trunk usually longer than the abdomen without the cercopods; abdomen of 9 segments, the last of which is always the shortest, segments usually cylindrical, sometimes flattened. Head of the male bearing an appendage of varying structure; head of the female usually unarmed. Antennae of the male with or without serriform appendages. Endopodites of all feet usually similar, structure of endopodites of the anterior pairs sometimes dissimilar. Last segment of the penis with a spinulose surface.

The members of this subfamily are inhabitants of both fresh and salt water. It includes five genera.

Key to genera of the subfamily Branchinellinae.

A. Antennae of the male provided with serriform appendages .. . *Branchinellites.*
AA. Antennae of the male devoid of serriform appendages.
  B. Frontal appendage of the male stalked, simple, projecting from the middle of the forehead .. .. *Eubranchinella.*
  BB. Frontal appendage of the male stalked, divided into two, projecting from the middle of the forehead or from the vertex.
    C. All segments of the abdomen flattened, cercopods joined forming a rounded keel .. .. *Thamnocephalus.*
    CC. All segments of the abdomen cylindrical, cercopods always distinct.
      D. Endopodites of all the legs of similar structure .. .. *Branchinella.*
      DD. Endopodites of the two anterior pairs of legs of different structure from the succeeding pairs .. .. *Dendrocephalus.*

Genus BRANCHINELLA Sayce, 1902.

Body of varying size; segments of the trunk with a smooth surface; segments of the abdomen in the male sometimes pointed at the posterior angles. Cercopods mobile, their margins setose. Head of the male with a stalked frontal appendage of varying structure and length. Antenna of the male with the basal segments distinct, apical segments usually falciform and unarmed. Apical segment of the penis elongated, armed with denticles.

This genus appears closely related to both *Branchinellites* and *Dendrocephalus.* Five species occur in New South Wales.

Key to species of Branchinella.

A. Frontal appendage in the male not exceeding the length of the basal segment of the antenna .. .. *australiensis.*
AA. Frontal appendage far exceeding the length of the antennae.
  B. Frontal appendage with numerous branches. .. ..*frondosa.*
  BB. Frontal appendage biramous.
    C. Second segment of the male antenna falciform.
      D. Rami of the frontal appendage armed with spines .. .. .. *eyrensis.*
      DD. Rami of the frontal appendage bearing rounded processes *ornata.*
    CC. Second segment of the male antenna shaped like a foot .. *probosoida.*

BRANCHINELLA AUSTRALIENSIS (Richters).

Branchipus australiensis Richters, Journal de Mus. Godeffroy, xii., p. 43.—*Branchinella australiensis* Sayce, 1902, p. 234, Plate xxx.

This species has not hitherto been recorded in New South Wales. A number of fine specimens of both males and females were obtained by Dr. W. Hull at

Wagga. It has also been collected in the Paroo River and on Tiltagoona Station in the Cobar district.

The species has been recorded from Queensland, Victoria, South Australia and Central Australia.

BRANCHINELLA EYRENSIS Sayce.

Proc. Roy. Soc. Vict., xv., 1902, p. 239, Plate xxxi.

A few specimens of this species were collected in water holes on Goorimpa Station on the Paroo River. It has not been recorded previously from New South Wales. The species was described from specimens collected in Central Australia.

BRANCHINELLA ORNATA (Wolf).

Branchinema ornata Wolf; *Branchinella ornata* Daday de Dees, 1910, p. 266. Fig. 40.

Male. Body graceful, trunk equal to the length of the abdomen without the cercopods or a little longer. Last segment of the abdomen very much shorter than the preceding segments, produced between the cercopods. Cercopods tapering at the apex, comparatively short, about equal to the combined length of the last two abdominal segments, margins with long setae. Vertical appendage of the head with a flattened stalk, dividing into two at about half its length; branches of the appendage bearing several rounded processes on both inner and outer margins, otherwise unarmed. Antennules comparatively long, considerably exceeding the length of the basal segment of the antennae. Antennae unarmed except for two small tubercles on the basal segment; apical segment falciform, inwardly curved, pointed at the apex. Feet all of similar structure. Length, 12 mm.

Female. Body very similar to the male. Antennules very much longer than the antennae. Antennae flattened, leaf-like, pointed at the apex, setose. Egg-sac fusiform, extending the length of the first three segments of the abdomen.

Distribution.—This species has not hitherto been recorded in Australia. Specimens were collected on Tiltagoona Station in the Cobar district. It has only previously been recorded from Africa.

BRANCHINELLA FRONDOSA, n.sp. (Plate xxviii.; Pl. xxix., figs. 1-4.)

Male (Fig. 1). Body robust, length of the trunk far surpassing that of the abdomen without the cercopods. Surface of the segments of both trunk and abdomen smooth and polished. Last segment of the abdomen about half the length of the preceding segment, slightly produced between the cercopods. Cercopods (Fig. 4) tapering towards the apex, directed towards each other; length almost attaining the combined length of the last four abdominal segments, setae long. Head (Fig. 3) comparatively large, rounded, a strong complicated appendage proceeding from the vertex; processes near the base very small and inconspicuous. Vertical appendage (Fig. 2) stalked and flattened basally; the basal portion narrowing at each end and broad in the middle; two main branches spring from this basal portion and these at once divide again into (1) one strong branch on the inside which remains undivided, (2) a strong branch which divides into three and these again bear smaller lateral branches, (3) a branch which bears lateral branches towards the apex. The whole structure has a tree-like appearance and extends as far as the fifth segment of the trunk, the surface

of the basal portion and the branches has a wrinkled appearance; the branches are provided with straight and curved spines. Antennules small, filiform, not attaining the length of the first segment of the antennae. Antennae (Fig. 3) composed of two segments, apical segment strongly curved and provided with a row of strong denticles. Exopodites of all the legs of similar structure (Fig. 5). Penis (Fig. 6) composed of two segments, the first very short, the second elongated, provided with a series of strong curved denticles along the sides. Length, 18 mm. Colour when alive transparent, cercopods a vivid orange-colour, of spirit specimens milky white.

Female (Plate xxix., fig. 1). Similar to the male in general structure. Antennae (Fig. 2) flattened and leaf-like, produced apically into a narrow point. Egg-sac (Figs. 3 and 4) strongly built, seen laterally, triangular, tapering at the apex, with a protruding lip. Length, 20 mm.

This species greatly resembles the genus *Dendrocephalus* in the form of its frontal appendage, but in every other respect it appears to be a true *Branchinella*, the exopodites of the legs all being of similar structure and the male antennae devoid of appendages. It is this species that is referred to in Whitelegge's list (1889, p. 318) as *Chirocephalus* sp.

Distribution.—N.S.W.: Yass.

BRANCHINELLA PROBOSCIDA, n.sp. (Plate xxix., figs. 5-9; Pl. xxx., figs. 1-3.)

Male (Fig. 5). Body moderately robust; trunk almost equal to the length of the abdomen without the cercopods; all the segments with a smooth polished surface; last segment of the abdomen shorter than the preceding segments, not produced between the cercopods. Cercopods (Fig. 6) long, tapering towards the produced apex; equal in length to the four preceding segments combined, setae on the margins very long and delicate. Head of moderate size, bearing an elongated, segmented appendage which branches terminally and which almost reaches the end of the abdomen; this appendage can be coiled up and, when in this position, does not reach the end of the antenna; it is composed of about twenty segments before the bifurcation, the two branches of the latter broaden in the centre and taper apically: they are covered with small hairs and bear several rows of spines along the inner edges. Antennules filiform, slightly exceeding the length of the first segment of the antennae. Antennae (Fig. 9) of very unusual structure for the genus, first segment broad and without appendages, apical segment shaped somewhat like a foot, the margins of the apical portion finely serrated. Penis (Fig. 7) with an elongated apical segment, rounded at the apex and bearing rows of strong spines. Length, 14 mm. Colour similar to that of the preceding species.

Female (Fig. 1). Similar in size and general structure to the male. Antennae (Fig. 2) flattened, leaf-like, produced to a narrow projection apically. Egg-sac (Fig. 3) comparatively long and narrow, extending the length of four segments, deeply lobed at the apex.

Distribution.—N.S.W.: Dubbo, Marra and Budda Stations (Darling River).

Suborder **Conchostraca.**

Body enclosed by a bivalved carapace. Eyes sessile, either coalescent or closely contiguous. Antennules small. Antennae large, used as organs of locomotion. One or two pairs of legs in the male modified as clasping organs. Tail piece compressed, usually armed with spines.

Key to families of Conchostraca.

A. Carapace with concentric lines of growth round a more or less prominent umbo .. .. *Limnadiidae.*
AA. Carapace spheroidal, without lines of growth .. .. *Limnetidae.*

Family LIMNADIIDAE.

Carapace compressed, with a varying number of lines of growth. Head of medium size, showing little difference in the two sexes. Tail-piece well developed, forming two lamellae with varying armature. Legs numerous, endites short; first and second pairs in the male usually prehensile.

Five genera occur in New South Wales.

Key to genera of Limnadiidae.

A. Dorsal organ present.
 B. 26-32 pairs of legs; dorsal margin of the carapace with spiny processes. *Limnadopsis.*
 BB. About 18 pairs of legs, no spiny processes on the dorsal margin of the carapace.
  C. Umbones inconspicuous or absent, few lines of growth .. . *Eulimnadia.*
  CC. Umbones large and prominent, numerous lines of growth *Paralimnadia.*
AA. Dorsal organ absent.
 B. First pair of legs only prehensile in the male; antennules simple .. .. *Cyclestheria.*
 BB. First two pairs of legs prehensile in the male; antennules lobed . *Estheria.*

Genus Limnadopsis Spencer and Hall, 1896.

Carapace ovate, compressed, narrower in the male than in the female; valves thin and like parchment. Lines of growth distinct, prolonged dorsally to form a series of spines on the dorsal margin of the carapace. Dorsal organ present. 26-32 pairs of legs, first two pairs prehensile in the male.

Key to species of Limnadopsis.

A. 30 or more pairs of legs present.
 B. Tail-piece armed with about fifty spines .. .. *squirei.*
 BB. Tail-piece with not more than eighteen spines .. .. *parvispinus.*
AA. 26 pairs of legs.
 B. Tail-piece with few spines of various sizes, carapace pitted .. .. *tatei.*
 BB. Tail-piece with small spines of uniform size, carapace pustulate . *brunneus.*

Limnadopsis birchii (Baird).

Estheria birchii Baird, Proc. Zool. Soc. London, 1860, p. 392.—*Limnadopsis squirei* Spencer and Hall, 1896, p. 239, figs. 15-19.

Distribution.—N.S.W.: Namoi River, Broken Hill. South Australia; Central Australia.

Limnadopsis parvispinus, n.sp. (Plate xxxii., figs. 1-7.)

Male (Fig. 1). Carapace irregularly oval in outline, moderately compressed; dorsal margin forming almost a right angle with the anterior margin and an obtuse angle with the posterior margin; anterior margin straight, ventral margin evenly curved; dorsal margin depressed before the umbo, curving convexly im-

mediately after the umbo. 12-14 well marked lines of growth; the carapace valves between the lines of growth smooth and polished. Processes on the dorsal margin of the carapace (Fig. 7) small and inconspicuous, 5 or 6 present in the posterior portion. Head of moderate size (Fig. 3), rostrum long and triangular. Antennules equal in length to the basal segment of the antennae. About thirty pairs of legs; first two pairs (Fig. 4) very much modified to form clasping organs. Tail-piece (Fig. 2) strongly built, end-claws longer than the lamellae, provided with a series of spines along three-quarters of their length, the remaining portion being provided with hairs; free margins of the lamellae curved, bearing about eighteen spines of uniform size and a larger spine at each end. Length, 16 mm. Colour yellowish-green, transparent.

Female (Fig. 5) slightly different from the male in the general shape of the carapace, the height being greater in proportion to the length; dorsal margin more evenly curved from the convexity behind the umbo to the posterior angle. Head larger than the male, but possessing a shorter and less conspicuous rostrum. Antennule shorter than in the male, not reaching the end of the basal segment of the antennae. Legs as in the male except that the first two pairs are not modified for clasping. Tail-piece (Fig. 6) with the free margins less curved than in the male and the end-claws not so strongly armed.

Distribution.—N.S.W.: Lake Cowal (Bland district), Mossgiel.

Genus PARALIMNADIA Sars, 1896.

Shell compressed, valves thin; lines of growth inconspicuous, very numerous; umbones large and prominent. Propagation sexual.

This genus was suggested by Sars in 1896 for the species known as *Eulimnadia stanleyana* (King). It is closely allied to both *Limnadia* and *Eulimnadia*.

PARALIMNADIA STANLEYANA (King).

Limnadia stanleyâna King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.—*Eulimnadia stanleyana* Sars, 1895, p. 16, Plate 2, figs. 1-12, Plate 3, figs. 1-10.

Distribution.—N.S.W.: Coogee, Maroubra, Bondi.

Genus EULIMNADIA Packard, 1873.

Carapace narrowly oval in lateral view, usually only 4 or 5 lines of growth. Flagella of the second antennae 9—10-segmented. 18-20 pairs of legs.

EULIMNADIA SORDIDA (King).

Limnadia sordida King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.—*Eulimnadia rivolensis* Brady, Proc. Zool. Soc. London, 1886, p. 87, fig. D.

This species was very briefly described by King and since he did not publish any figures, it was difficult to identify. Sars (1895, p. 17) suggested it might be synonymous with *Paralimnadia stanleyana*, while Sayce (1902, p. 245) considered that it was probably the same form as that described by Brady (1886, p. 87) as *Eulimnadia rivolensis*. The original specimen described is figured in King's manuscript and the drawings show without doubt that Sayce's opinion was correct. A detailed description of this species is given by Sayce (1902, p. 245, Plate xxxii.) under the name of *Eulimnadia rivolensis* Brady.

Distribution.—N.S.W.: Botany Bay, Moore Park, Nelson's Bay, Myall Lakes, Lismore. Victoria; South Australia; Central Australia.

Genus ESTHERIA Rüppell, 1857.

Carapace oval, 10-22 lines of growth usually very distinct. Dorsal organ absent. 24-28 pairs of legs. Six species are described from Australia, three of which occur in New South Wales.

Key to species of Estheria.

A. Tail-piece bearing numerous anal denticles.
  B. More than 20 lines of growth . . . . *packardi.*
  BB. Less than 20 lines of growth.
    C. Marginal area of the carapace with crowded concentric striae . *elliptica.*
    CC. Marginal area without any striae . . . . *rubra.*
AA. Tail-piece with few (less than ten) anal denticles.
  B. Dorsal margin forming a distinct angle with the posterior margin . . *sarsii.*
  BB. Dorsal margin joining the posterior without any angle.
    C. Eyes confluent . . . . *lutraria.*
    CC. Eyes separate . . . . *dictyon.*

ESTHERIA PACKARDI Brady.

Brady, Proc. Zool. Soc. London, 1886, p. 85, fig. C.

This appears to be the commonest species of *Estheria* in Australia, and usually occurs in large numbers. An account of its development was given by Sars in 1896 and a detailed description of the adult form in 1895 (p. 28, Plate 4, figs. 1-9, Plate 5, figs. 1-9).

Distribution.—N.S.W.: Botany, Hay, Dubbo, Trangie. South Australia; Central Australia; Victoria; Queensland.

ESTHERIA LUTRARIA Brady.

Proc. Zool. Soc. London, 1886, p. 85, fig. B.

Estheria lutraria is the largest species of the genus that occurs in Australia; it has not hitherto been recorded in New South Wales.

Specific characters. Carapace, seen laterally, with a very straight dorsal margin which meets the curved posterior margin without any definite angle. Umbo small and pointed, situated very close to the anterior end, dorsal margin sloping very obliquely from the umbo to the posterior end. Anterior margin much broader than the posterior. Surface of the carapace with an average of fourteen lines of growth, distinctly marked and bearing small hairs; surface between the lines marked with an irregular reticulation. Tail-piece comparatively short, dorsal margins of the lamellae deeply concave, about five small denticles; end-claws bearing feathered setae along half their length. Length of fully grown specimens attaining 14 mm.

Distribution.—N.S.W.: Dubbo, Broken Hill. South Australia; Central Australia.

ESTHERIA RUBRA, n.sp. (Plate xxxii., Figs. 8-9.)

Carapace (Fig. 8), seen laterally, irregularly oval in outline; dorsal margin forming a distinct obtuse angle with the posterior margin; anterior margin

broadly rounded; posterior margin curved, narrower than the anterior. Umbones very prominent, situated fairly far forward. Seen from above not very tumid, greatest width occurring considerably in front of the middle, anterior end broader than the posterior. Surface of the carapace marked by about 12 distinct lines of growth which are provided with short bristles; between the lines the surface is marked by an irregular reticulation, no concentric striae on the outer margin. Dorsal margin bearing two or three small spines. Valves of firm consistency and moderately thick. Head comparatively large, eyes confluent, situated behind a somewhat round projection of the head. Last segments of the trunk with well marked spines, situated on small projections. Tail-piece (Fig. 9) well developed, a strong pair of denticles and two smaller pairs occurring in front of the caudal setae; dorsal margin curved, bearing a total number of 18-20 pairs of denticles, last pair very large; end-claws strong, bearing feathered setae along half their length and very small hairs or bristles along the remaining half. Colour of living specimens bright red to reddish-brown. Length, 6 mm.

Distribution.—N.S.W.: Marra and Budda Stations on the Darling River and Gooimpa Station on the Paroo.

Family LIMNETIDAE.

Carapace spheroidal, without lines of growth. Head large, not included in the carapace. First pair of legs prehensile in the male. Tail-piece undeveloped. Only one genus, *Limnetis*.

Genus LIMNETIS Lovén.

Carapace without umbones; surface smooth. Head produced into a large rostrum. Tail-piece unarmed.

Two species occur in New South Wales.

Key to species of Limnetis.

A. Rostrum in the female broadly rounded .. .. *macleayana.*
AA. Rostrum in the female narrow, long, notched at each side .. .. *tatei.*

LIMNETIS MACLEAYANA King.

Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.

Female. Carapace, seen laterally, of irregularly rounded shape, the greatest height not as long as the length and occurring in front of the middle. Seen from above, oval with the greatest width in the middle; anterior and posterior ends pointed, and of equal width. Rostrum very broad and obtusely rounded at the end. Eyes of moderate size, ocellus almost as large as the eyes. Twelve pairs of legs diminishing in size posteriorly. Tail-piece very small, ending in two rounded lobes, each of which bears a tiny spinule. Colour in the living animal, jade green. Length up to 7.5 mm.

Male. Very like the female in general form, except that the posterior end is narrower. Rostrum shorter than that of the female and transversely truncated at the tip. Ten pairs of legs, the first of which are modified as grasping organs.

Distribution.—N.S.W.: Botany, Liverpool, Denham Court, Hay, Myall Lakes, Paroo River. It has also been recorded from Victoria.

LIMNETIS TATEI Brady.

Proc. Zool. Soc. London, 1886, p. 84.

Female. Carapace, seen laterally, rounded, greatest height occurring considerably in front of the middle. Seen from above oval, the greatest width be-

ing in the middle. Head comparatively larger than in the preceding species, rostrum produced, seen laterally, pointed at the apex; seen from in front, obtuse at the apex and with a well defined notch at each side. Legs similar to those of the preceding species. Colour in living specimens yellowish-green. Length up to 3 mm.

Male. Rostrum elongated, transversely truncated at the apex, the terminal edge bearing a fringe of cilia.

This species is more rarely found than the preceding one but is usually in large numbers when it occurs.

Distribution.—N.S.W.: Sydney, Botany, Maroubra. Victoria; South Australia.

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EXPLANATION OF PLATES XXVIII.-XXXII.

Plate xxviii.

Branchinella frondosa ♂.

Fig. 1.—Lateral view (x 15); Fig. 2.—Frontal appendage (x 28); Fig. 3.—Head (x 20); Fig. 4.—Cercopods (x 20); Fig. 5.—First leg (x 100); Fig. 6.—Penis (x 100).

Plate xxix.

Figs. 1-4 *Branchinella frondosa* ♀.

Fig. 1.—Head (x 30); Fig. 2.—Antenna (x 35); Fig. 3.—Egg-sac (x 30); Fig. 4.—Egg-sac, lateral view (x 30).

Figs. 5-9 *Branchinella proboscida* ♂.

Fig. 5.—Lateral view (x 15); Fig. 6.—Cercopods (x 30); Fig. 7.—Penis (x 60); Fig. 8.—First leg (x 150); Fig. 9.—Antenna (x 60).

Plate xxx.

Figs. 1-3 *Branchinella proboscida* ♀.

Fig. 1.—Head (x 15); Fig. 2.—Antenna (x 30); Fig. 3.—Egg-sac (x 30).

Figs. 4-7 *Branchinecta tenuis* ♂.

Fig. 4.—Lateral view (x 10); Fig. 5.—Antenna (x 15); Fig. 6.—Cercopods (x 15); Fig. 7.—First leg (x 150).

Plate xxxi.

Branchinecta parooensis ♂.

Fig. 1.—Lateral view (x 5); Fig. 2.—Antenna (x 7); Fig. 3.—Cercopods (x 10); Fig. 4.—First leg (x 20).

Plate xxxii.

Figs. 1-7 *Limnadopsis parvispinus*.

Fig. 1.—Lateral view ♂ (x 3); Fig. 2.—Tail-piece ♂ (x 9); Fig. 3.—Head ♂ (x 9); Fig. 4.—Modified leg ♂ (x 12); Fig. 5.—Lateral view ♀ (x 3); Fig. 6.—Tail-piece ♀ (x 9); Fig. 7.—Dorsal margin (x 7).

Figs. 8-9 *Estheria rubra*.

Fig. 8.—Lateral view (x 10); Fig. 9.—Tail-piece (x 25).

NOTES ON AUSTRALIAN DIPTERA. No. ii.

By J. R. MALLOCH.

[Read 28th May, 1924.]

Family MUSCARIDAE.

Subfamily ANTHOMYIINAE.

Genus HYLEMYIA Robineau-Desvoidy.

This genus is most abundantly represented in the northern hemisphere and especially in Europe and the northern and mountainous sections of North America. Africa and South America have so far produced very few representatives of the genus and only 3 are known to me as occurring in Australia, one of these, *cilicrura* Rondani, being of world-wide distribution.

It is possible that collecting in forested mountainous sections may yet produce more Australian species, though those already known will probably be found to be associated with cultivated crops, which is certainly the case with *cilicrura*.

I present herein a key for the identification of the three species known to me. Failure to associate one of the species with any already described has compelled me to describe it as new. The type and allotype specimens will be returned to Dr. E. W. Ferguson.

The complete sixth wing-vein, presence of a bristle at base of hind metatarsus on its ventral surface, and of fine sparse soft hairs on the ventral surface of scutellum will serve to distinguish the genus from its allies in Australia. The thorax has 2 + 3 dorsocentral bristles, the first posterior cell of wings is very slightly narrowed at apex, and the lower calyptra is smaller than the upper.

Key to Australian species of Hylemyia.

1. Wing with conspicuous black spots as follows: at apex of first vein, junction of second and third veins, on fourth vein at base of discal cell, and on both extremities of both cross-veins; thorax with three broad brown vittae, the median one extending over scutellum .. .. *deceptiva* Malloch.
   Wing without black spots; thorax not, or indistinctly, vittate 2
2. Hind tibiae of male with a series of erect setulose hairs on posteroventral surface from base to apex, which are as long as diameter of tibia; hind femur in same sex with some strong bristles on apical half of anteroventral surface, the posteroventral surface unarmed, fore tibia with a stout curved blunt-tipped spur at apex on posterior side; hind tibia in both sexes with about six anterodorsal bristles of irregular lengths; prealar bristle distinct .. .. *cilicrura* Rondani.
   Hind tibia in male without erect posteroventral hairs, femur with long fine bristles on entire length of anteroventral surface, the tips of which are

very fine, and a series of similar but weaker bristles on posteroventral surface, which do not extend to apex, fore tibia with a short sharp-tipped straight bristle at apex on posterior side; both sexes with two or three anterodorsal and two posterodorsal bristles; prealar bristle absent .. .. *urbana*, n.sp.

HYLEMYIA DECEPTIVA Malloch.

I have seen a large series of specimens of this species from Illawarra and Botany Bay, N.S.W., sent to me by Dr. C. F. Baker, Philippine Islands. Originally described from New Zealand, Sydney, N.S.W., and Adelaide, S.A.

Readily distinguished from its allies by the spotted wings. Length, 4-5 mm.

HYLEMYIA CILICRURA Rondani.

I have but two females of this species before me from Australia. It has been recorded also by Stein. The species is very widely distributed, the larvae feeding in the sprouting seeds of maize, beans, etc. Same size as last species.

HYLEMYIA URBANA, n.sp.

Male and female.—Black, densely covered with brownish-grey pruinescence. Thorax faintly or not at all vittate with brown. Abdomen with a series of dark spots in middle of dorsum, which are rather indistinct in male and sometimes absent in female. Interfrontalia on female rufous in front, darker above. Legs black. Wings hyaline. Calyptrae whitish. Halteres yellow.

Male.—Frons linear above; arista pubescent; parafacial about as wide as third antennal segment, and narrower than height of cheek. Thorax with a sparse double row of presutural hairs and no prealar bristle. Abdomen depressed, as in *cilicrura*, none of the segments with abnormal armature. Fore tibia with one or two posterior and one anterodorsal setula beyond middle; mid tibia with one anteroventral, one anterodorsal, one or two posterodorsal, and two posteroventral bristles; hind femur as described in key; hind tibia with two or three anterodorsal, two posterodorsal, and from two to four anteroventral bristles, the last very short. First posterior cell of wings slightly narrowed apically; costal thorns both distinct.

Female.—Frons fully one-third of the head width, with a pair of cruciate interfrontal bristles. Tibiae as in male, but the hind femur with sparse anteroventral bristles which do not extend to base, and the posteroventral surface bare.

Length, 4 mm.

Type, male, allotype, eight male, and one female paratypes, Sydney.

One female from Sydney has three posterodorsal and two anterodorsal bristles and may represent another species, but more material is necessary to warrant a decision.

Subfamily PHAONIINAE.

It is becoming more and more difficult to separate the so-called families Muscidae and Anthomyiidae of authors, and it is evident to me that, while within any one of the larger faunal regions of the world it is not impossible to designate characters which will serve for that purpose, it is impossible to make these or any other set of characters apply to the whole complex when the whole world's fauna is considered. I have in fact dropped the family Anthomyiidae in preference to Muscaridae or Muscidae in all of my recent papers, using subfamily groups of which Muscinae or Muscarinae will form one.

The separation of Phaoniinae and Muscarinae is difficult, and it may be necessary yet to consider these groups as forming one subfamily as the limits

are very difficult to arrive at. There are, however, in the former, no species which have the fourth vein of the wings angularly bent forward at or before the middle of its last section as in typical *Musca*, the bend when present occurring beyond the middle, and the lower calyptra in Muscarinae is almost invariably noticeably truncate at apex, while in the other group it is narrower and more distinctly rounded, with its inner posterior angle well separated from the anterior lateral angle of scutellum, which is not the case in Muscarinae.

DICHAETOMYIA ARMATA Stein.

Male and female.—Fulvous yellow, distinctly shining. Frons black, with white pruinescence, interfrontalia paler, brownish in female; antennae and palpi yellow, third segment of former whitish pruinescent in male, a little darkened in female. Thorax with three whitish pruinescent vittae on dorsum, giving it the appearance of being quadrivittate with rufous yellow. Apex of abdomen in male more or less infuscated. Legs entirely tawny yellow. Wings, calyptrae and halteres yellowish.

Male.—Eyes bare; frons over twice as wide as third antennal segment, orbits distinct, each with six or seven bristles, the upper three or four curved backward; parafacial eliminated below when head is seen from the side; cheek narrow; longest hairs on arista about twice as long as width of third antennal segment. Thorax with $2 + 4$ dorsocentral bristles; prealar short; hypopleura hairy below spiracle. Fore tibia with one long fine posterior bristle at middle; mid femur normal; mid tibia with rather dense black hairs on ventral surface that are longer than diameter of tibia, and two long fine posterior bristles; hind femora swollen from near base, at base of swollen part, about one-fourth from base of femur, on ventral surface with a dense clump of short black downwardly directed bristles, the apices of which are flexed towards apex of femur, a very long strong thorn at one-third from apex on same surface, which is as long as from its base to apex of femur, sloped towards base of femur, and curved at tip, some of the anterior bristles also strong; hind tibia slightly curved, with one anterodorsal median bristle and some fine black anteroventral and posterodorsal hairs or setulae. Wings normal.

Female.—Frons nearly one-third of the head width, upper two orbitals on each side backwardly directed. Fore tibia with one anterodorsal and one posterior median bristle; mid tibia with or without a short anterodorsal bristle, with two bristles and some short setulae on posterior side; hind femur with one or two strong preapical anteroventral bristles; hind tibia with two anterodorsal, two or three anteroventral bristles and a few posterodorsal setulae. Otherwise as male.

Length, 7 mm.

Originally described from an unrecorded locality in a key which does not give sufficient data to make the identification of the species absolutely certain, but, owing to the fact that I have what is evidently the same species from the Philippines, I accept the name for this species even should Stein's name be considered a *nomen nudum*. I suspect that *Mydaea rigidiseta* Stein, described from New Guinea, is merely this species, the type having but three pairs of postsutural dorsocentrals and the abdomen with black spots. I have one such specimen from Queensland before me now.

Localities.—Glenreagh, N.S.W., February 1, 1923, Coramba-Dorrigo Rd., 1,000 feet, January 31, 1923; Eidsvold, Queensland.

PHAONIA UMBRINERVIS Stein.

Male and female.—Black, slightly shining, with drab-coloured dusting. Mesonotum, when seen from behind, with four narrow black vittae. Abdomen, when viewed from behind, with an elongate black spot on each tergite, forming an interrupted central vitta, less noticeable in female. Legs black. Wings slightly smoky, both cross-veins broadly black. Calyptrae greyish. Knobs of halteres fuscous.

Male.—Eyes almost bare; narrowest part of frons about one-eighth of the head width, orbits linear, with long setulae on anterior half; parafacials silvery, nearly as wide as third antennal segment; cheek one-third as high as eye; arista sparsely plumose, the longest hairs as long as width of third antennal segment; palpi normal, slender. Thorax with dorsocentrals $2 + 3$; prealar absent; both intra-alars long; acrostichals in two series, three pairs in front of suture, one pair conspicuous; sternopleurals 1:2; hypopleura bare. Abdomen elongate ovate; basal sternite bare, fifth with a deep rounded posterior emargination. Fore tibia without a median posterior bristle; mid tibia with two posterior bristles; hind femur with a complete anteroventral and posteroventral series of bristles, the latter the weaker; hind tibia with two anterodorsal and three or four anteroventral bristles, the calcar of moderate length. Both costal thorns distinct; venation normal.

Female.—Differs from the male in having the frons about one-third of the head width, one upper orbital directed backward, hind femur without posteroventral bristles.

Length, 3.5-5 mm.

Originally described from one immature male from Botany Bay. I have before me a male from Sydney, July 15, 1923, and a female also from there, October 8, 1922.

PHAONIA FERGUSONI, n.sp.

Male.—Black, slightly shining. Thorax and abdomen rather densely grey pruinescent, the former with four broad black vittae, the latter with a dorsocentral black stripe which tapers apically. Legs black. Wings hyaline. Calyptrae gray, margins and fringes black. Halteres black.

Eyes densely haired; frons about one-ninth of the head width, orbits linear, setulose on their entire length, strongly so anteriorly; antennae missing in type; parafacial broad, over half as wide as height of cheek, the latter about one-fourth as high as eye. Thorax with $2 + 3$ dorsocentrals, two pairs of closely placed fine presutural acrostichals, the prealar short, scutellum normal, hypopleura bare, sternopleurals 1:2. Abdomen elongate-ovate, basal sternite bare or almost so. Fore tibia unarmed at middle; fore tarsus without erect sensory hairs; mid tibia with two posterior bristles; hind femur with a series of fine closely placed bristles on entire length of anteroventral surface, longer apically; hind tibia with four or five irregular anterodorsal bristles, the anteroventral surface with a series of long setulae, and the posterodorsal bristle rather short. Wing normal, outer cross-vein much curved.

Length, 11 mm.

Type, Mill, Allyn River, December 18, 1922 (Goldfinch).

The foregoing are the only two species which are definitely known as belonging to this genus from Australia. Stein has doubtfully referred *stupida* Walker here, but it may readily be separated from either, if it really is a *Phaonia*, by the reddish femora and tibiae, bluish abdomen, and the presence of four pairs of postsutural dorsocentrals.

As in the case of *Hylemyia,* this genus is most abundantly represented in Europe and North America, there being comparatively few species in South America, about half a dozen in Africa and none so far as I know in New Zealand. There are about 50 in North America, some of which occur also in Europe, where there are about the same number.

Some of the larvae occur under bark of fallen trees, and one is parasitic.

Genus HELINA Robineau-Desvoidy.

The species which I have referred to *Helina* from Australia fall into several more or less well marked groups, but in most cases these groups are slightly different from those found in Europe and North America. The species related to *addita* Walker are in many respects similar to the *duplicata* group found in these regions, but there are rather dense hairs on the eyes, which are not found as a rule in the European species which possess four sternopleural bristles. I note that there is a very decided tendency in the Australian and New Zealand species of some genera in this family to have the eyes hairy, whereas in other regions the allies of these species do not have the hairs or they are very indistinct.

Europe does not furnish any blue or green species of this genus, while there are many such species in Australia. The presence of fine hairs upon the hypopleura is a character which has been considered of sufficient importance to use as a differentiating character for the families Muscidae and Anthomyiidae by recent authors, but in many species of Anthomyiidae there are quite evident hairs on the hypopleura and, in some cases, I have concluded that they may be absent or present even in the same species. It is pertinent to note that some of the blue species referred to have these hairs and others do not, a condition which is found also in the other groups to some extent.

Possibly future workers on the family will arrive at a means of classification which will take into consideration the immature stages and biology while linking these up with characters which are not as yet evident to us and so arrive at a better understanding of the relationships of the groups. However, in the meantime, we must perforce rely upon characters which appear to associate rather diverse forms together and, under existing circumstances, there appears to be no recourse other than to adopt for the Australian species the generic name above used.

As limited here we have species which possess the following characters: Sixth wing-vein incomplete, not extending to margin of wing; hind tibia without a strong bristle beyond middle on posterodorsal surface; lower calyptra much larger than upper; wing veins bare, fourth not appreciably bent forward apically; fore femur not thorned at apex below in male; cruciate frontal bristles absent in female.

HELINA CALYPTRATA, n.sp.

Male.—Head black, parafacials silvery. Thorax black, with distinct white pruinescence and quadrivittate. Abdomen greenish-blue, with conspicuous whitish pruinescence, the sides of dorsum slightly checkered. Legs black. Wings rather noticeably brownish along costa, especially in subcostal cell and at inner cross-vein. Calyptrae white, margin of lower one yellowish. Knob of halteres fuscous.

Eyes distinctly hairy; narrowest part of frons narrower than third antennal segment; arista plumose; cheek twice as high as width of third antennal segment. Thorax with 2 + 3 dorsocentrals; prealar very short; strong presutural acro-

stichals absent; some fine hairs below metathoracic spiracle. Basal abdominal sternite bare. Fore tibia without a median posterior bristle; mid tibia with two posterior bristles; hind femur with rather short bristles on apical half of anteroventral surface and a series of short setulose hairs on posteroventral; hind tibia with two anterodorsal and one very short anteroventral bristle. Outer cross-vein curved, at about its own length from inner. Lower calyptra narrower than usual.

Female.—Similar to male, the eyes with very short hairs and the wing-veins rather noticeably yellowish margined, the outer cross-vein as distinctly so as the inner.

Length, 6-6.5 mm.

Type, male, Austinmer, N.S.W., December 19, 1921. Allotype, Sydney, October 29, 1922.

HELINA FLAVOFUSCA, n.sp.

Female.—Head black, with grayish pruinescence. Thorax reddish-yellow, with a poorly defined dorsocentral fuscous vitta. Abdomen brownish fuscous, with grayish pruinescence, the anterior lateral angles of tergites more or less flavous. Legs reddish-yellow, tarsi black. Wings, calyptrae, and halteres yellowish.

Eyes bare; frons a little less than one-third of the head width, orbits narrow, two upper bristles on each side curved backward; arista plumose. Dorsocentrals 2 + 3; one or two pairs of short widely separated presutural acrostichals present besides the short hairs; hypopleura bare; prealar very short. Fore tibia without a median posterior bristle; mid tibia with two posterior bristles; hind femur with about three anteroventral bristles on apical third; hind tibia with one anterodorsal and one anteroventral bristle. Venation normal, last section of fourth vein about 1.5 as long as preceding section.

Length, 5-6 mm.

Type, Sydney, July 21, 1923. Paratype, Sydney, May 19, 1923.

HELINA IMITATRIX, n.sp.

Female.—Head black, face, cheeks, and orbits whitish pruinescent, interfrontalia black, when seen from in front white pruinescent; basal two antennal segments tawny, third black; palpi tawny, infuscated apically. Thorax tawny, centre of disc with a broad poorly defined fuscous vitta, the usual 4 vittae reddish-brown but not very distinct; scutellum darker at base; a fuscous spot on upper anterior part of pteropleura; postnotum dark in centre. Abdomen fuscous, densely pruinescent, the dorsum checkered. Legs tawny, tarsi black. Wings grayish hyaline, both cross-veins rather broadly clouded. Calyptrae and halteres yellowish.

Eyes sparsely hairy; frons normal; arista with very short hairs; cheek about twice as high as width of third antennal segment; palpi normal; proboscis much stouter than usual. Thorax with 2 + 4 dorsocentrals and at least one pair of strong closely placed presutural acrostichals; prealar short but distinct; both intra-alars strong; sternopleurals 1:2. Abdomen normal. Fore tibia with a posterior median bristle; mid femur with about three ventral bristles at base; mid tibia with three posterior bristles; hind femur with two or three preapical anteroventral bristles; hind tibia with two anterodorsal and two to four anteroventral bristles. Outer cross-vein straight; first posterior cell slightly widened apically; both costal thorns distinct.

Length, 7 mm.

Type, Lorne, Victoria, October 23, 1918 (F. E. Wilson).

LIMNOPHORA OPACIFRONS, n.sp.

Female.—Head black, opaque, with dense white pruinescence on face, cheeks, and orbits, occiput lavender-gray pruinescent except in centre where it is brown; interfrontalia when seen from in front whitish, from the side brown in middle and black on sides. Mesonotum and pleura lavender-gray pruinescent, the former with five dark brown vittae, the pleura dark brown on upper margin; scutellum dark brown. Visible tergites 1 to 3 each with a pair of very large transverse fuscous brown spots which are narrowly separated in middle and extend entirely across dorsum at posterior margin leaving only a transverse gray pruinescent area on each side anteriorly; fourth tergite with a large irregular central mark of same colour. Legs black, with grayish pruinescence. Wings clear. Calyptrae white. Halteres yellow.

Eyes almost bare; frons one-fourth of the head width; each orbit with two recurved upper bristles; face concave; cheek higher than width of third antennal segment; arista very shortly pubescent; palpi slightly broadened. Thorax with 2 + 4 dorsocentrals; both intra-alars distinct; sternopleurals 1:1 or 0:1. Abdomen without genital thorns. Fore tibia without a median posterior bristle; mid tibia with one posterior bristle; hind femur with one preapical anteroventral bristle; hind tibia with one anterodorsal bristle. First posterior cell of wing hardly narrowed apically; last section of fourth vein about 2.5 as long as preceding section; outer cross-vein curved, slightly deflected towards base of wing at upper margin, and at its own length from inner.

Length, 5 mm.

Type, Coramba-Dorrigo Rd., 1,000 feet, N.S.W., January 31, 1923.

LIMNOPHORA NIGRIORBITALIS, n.sp.

Female.—Similar to *opacifrons*. Differs in having the entire frons including orbits opaque black when seen from the side; the face silvery; mesonotum with the vittae fused so that only the lateral margins are pale gray pruinescent; and the black abdominal spots are not separated in middle.

The species is more slender and even less strongly bristled than is *opacifrons*. Thoracic dorsocentrals 2 + 3. Bristles of legs as in last species, but the hind femur in type has no preapical anteroventral bristle. Wings narrower than in *opacifrons*, but in other respects similar, except that the outer cross-vein is directed slightly towards apex instead of base of wing at its upper extremity. In both species the setulae at base of third wing-vein are very fine and short.

Length, 4 mm.

Type, same as last species.

LIMNOPHORA ORTHONEURA, n.sp.

Male.—Head black, with silvery pruinescence, that on interfrontalia visible only when seen from in front. Thorax shining black, densely whitish pruinescent on dorsum except on two large subquadrate marks in front of suture and a broad transverse mark behind suture which shows traces of divided vittae along its posterior margin when seen from behind; scutellum gray pruinescent at apex. Abdomen with basal tergite entirely black, a pair of large subtriangular fuscous spots on second and another on third visible tergites, fourth with a less distinct

central brownish mark. Legs black. Wings hyaline. Calyptrae white. Halteres yellow.

Eyes bare; frons one-third of the head width; face concave in profile, vibrissal angle not projecting beyond level of base of antennae; cheek not as wide as third antennal segment; parafacial linear in middle; arista pubescent, thickened on basal half, hardly longer than antenna. Thorax with 2 + 3 dorsocentrals; mesonotal hairs rather strong. Abdomen elongate ovate; hypopygium small. Fore tibia unarmed at middle; mid femur with two or three posteroventral bristles near base; mid tibia with two posterior bristles; hind femur with two strong preapical anteroventral bristles; hind tibia with one anterodorsal and one anteroventral bristle. First posterior cell not narrowed at apex; inner cross-vein but little beyond middle of discal cell; outer cross-vein straight, at not more than half its own length from apex of fifth; last section of fourth vein not over 1.5 as long as preceding section.

Female.—Similar to male, arista longer, abdomen pointed at apex.

Length, 3 mm.

Type, Belaringar, N.S.W., May 31, 1923. Allotype, Fish River, N.S.W., March 25, 1923.

This species belongs to the *triangula* group, in which the eyes are widely separated in the male. There are some closely related species in Formosa and elsewhere in the Orient, some of which have yet to be described, though they were included in a key to oriental species published by Stein some years ago.

Genus ATHERIGONA Rondani.

This genus has usually been placed in the subfamily Coenosiinae but it belongs without doubt in the Phaoniinae, though an aberrant group.

ATHERIGONA TIBISETA, n.sp.

Male.—Testaceous yellow, subopaque. Third antennal segment and arista fuscous brown; palpi yellow; interfrontalia orange; frontal orbits whitish pruinescent; occiput dark gray on upper half, with yellowish pruinescence. Disc of mesonotum, scutellum and metanotum fuscous, densely gray pruinescent; humeral angles broadly yellowish, mesonotum with a faint brown central vitta. Abdomen with a brownish mark in centre of first visible tergite and a pair of large elongate black spots on second and third. Legs yellow, bases of fore tarsi darker. Wings hyaline. Calyptrae and halteres yellow.

Arista almost bare, moderately thickened on more than the basal half; palpi short and stout, with three or four short black bristles at base of each on their outer sides, the apical hairs pale. Thorax normal. Abdomen normal, first and second visible tergites equal, third about half as long as second; hypopygial prominence short, with a slender process on each side directed backward and tapered a little at tips, and below the level of these, which are separated by a distance about equal to their length, there is an almost indistinguishable wart or short process in centre. Fore tarsus with a few short erect fine hairs along the anterior side of basal segment and one or more similar hairs at apices of the other segments, which are about as long as the diameter of the segments; fore tibia with about eight long black hairs on apical half of ventral surfaces, the longest of which are as long as basal segment of fore tarsus; fore femur normal for the typical group; mid and hind legs as in genotype. Inner cross-vein at about two-fifths from base of discal cell; first posterior cell not noticeably narrowed at apex; outer cross-vein erect.

Length, 3 mm.

Type, Sydney, April 2, 1923 (Mackerras).

There is no other species of the genus so far described which has the fore tibia as in this one. Several Indian and African species have fine hairs on the fore tarsi in the males. These hairs are not present in the females.

Subfamily FANNIINAE.

Genus EURYOMMA Stein.

This genus may be distinguished from *Fannia* by the widely separated eyes of the male, the frons being one-third of the head width. There is but one strong presutural dorsocentral bristle instead of two and the prealar bristle is not duplicated.

The presence of one or two setulose hairs on hind coxa above base of femur, the abbreviated sixth and seventh wing-veins with the seventh longest and curved round the apex of sixth, and the fact that the two upper orbital bristles on each side of frons are directed outward over eyes, will separate the genus from others occurring in Australia.

EURYOMMA PEREGRINUM Meigen.

Black, densely yellowish-gray pruinescent. Basal two antennal segments, palpi, legs except tarsi, and the abdomen tawny yellow; third antennal segment and tarsi black.

Arista almost bare. Postsutural dorsocentrals 3 pairs, the anterior one short. Fore tibia with a very short anterodorsal setula beyond middle; mid tibia with one anterodorsal and one posterodorsal bristle; hind femur with two strong preapical anteroventral bristles; hind tibia with one anteroventral, one anterodorsal and one posterodorsal bristle close to middle. Lower calyptra hardly protruded.

Length, 2.5-3.5 mm.

One female, Sydney, July 26, 1923.

A cosmopolitan species. Probably the larva lives in decaying vegetable matter.

EUCALYPTS OF THE BLUE MOUNTAINS AND THEIR DEFINED AREAS.

By E. C. Chisholm, M.B., Ch.M.

[Read 28th May, 1924.]

In travelling on foot across the Blue Mountains from Lapstone Hill to Clarence, and by car to Mount Wilson, where I spent the best part of two days on two separate occasions, and taking a day at different places, I have endeavoured to locate different species of Eucalypts and define their boundaries. In doing this I must acknowledge great help from the paper of J. H. Maiden and R. H. Cambage, "Eucalypts of the Blue Mountains," (These Proc., 1905, p. 190), which enabled me to locate most of the species with comparative ease. Two species they mention, viz., *E. macrorrhyncha* and *E. melliodora,* I have not been able to find, probably because our routes differed after Mount Victoria, they going by way of Hartley and Bowenfels, whereas I went by way of the main western line to Clarence. With Mr. W. F. Blakely's assistance I was able to add three (Nos. 10, 20, 30 below) near Blaxland, new records for the mountains, though he deserves the credit for the discovery. I have extended the range of several others. Both Mr. Blakely and I failed to find *E. notabilis* about Blaxland, although Glenbrook is its type locality (February, 1923). *E. Dalrympleana* is recorded for the first time from the Blue Mountains.

Eucalypts found on the Blue Mountains.

1. *E. Moorei* Maiden and Cambage.—Found from half a mile south of Nellie's Glen, Katoomba, and near Minne-ha-ha Falls on the north of the railway to between Hartley Vale railway station and Bell.

2. *E. coriacea* A. Cunn.—A few trees, between Newnes Junction and Clarence.

3. *E. coriacea* variety.—A Mallee type of tree with narrow leaves found in quantity between Newnes Junction and Clarence, being seen right up to Newnes Junction platform. This is an interesting form.

4. *E. radiata* Sieb.—From Lawson, on the north side of the railway in gully near Frederica Falls, right through to Mount Wilson and Clarence.

5. *E. fastigata* Deane and Maiden.—From bottom of Wentworth Falls in the Jamieson Valley and along the Federal Pass from "The Tables" at Leura, some distance towards Katoomba, at any rate to under "The Three Sisters" and again at Clarence. This becomes a very fine tree in the Jamieson Valley, in great contrast to those found at Clarence, which were of poor growth.

6. *E. dives* Schau.—I first came across this at Mount Victoria, on the south-west side of the railway in the catchment area of the reservoir, and again at Clarence, also at Katoomba.

7. *E. Blaxlandi* Maiden and Cambage.—From Katoomba right through to Clarence, always on top of the range or just below.

8. *E. eugenioides* Sieb.—From Lapstone right through to Clarence, though I have not recorded it for Blackheath. This is the commonest Stringybark on the Mountains.

9. *E. ligustrina* DC.—This dwarf form found at Wentworth Falls on top

of the range, but it seems to have a limited area here. Common on King's Tableland.

10. *E. agglomerata* Maiden.—Found by Mr. W. F. Blakely and myself near Warrimoo, about 3 miles west of Blaxland, and apparently not very numerous.

11. *E. piperita* Sm.—Found right through from Lapstone to Clarence. One of the commonest Eucalypts.

12. *E. stricta* Sieb.—From Wentworth Falls to Clarence and on the road to Mount Wilson from Bell. Found mostly on the edge of the escarpment or in other exposed places.

13. *E. altior* Deane and Maiden (= oreades Baker and Smith).—From Lawson to Bell.

14. *E. micrantha* DC.—From Lapstone in patches right through to Clarence, though I did not find it at Springwood.

15. *E. Sieberiana* F.v.M.—First seen in the neighbourhood of Lawson and right on to Clarence.

16. *E. Consideniana* Maiden.—First seen near 40-mile stone on main western road, about a mile west of Blaxland, and also at Springwood, where it is fairly numerous.

17. *E. paniculata* Sm.—Found on Lapstone side of Blaxland, about half a mile east of the latter.

18. *E. crebra* F.v.M.—On Lapstone Hill and about Glenbrook.

19. *E. siderophloia* Benth.—On Lapstone side of Blaxland. There is a narrow belt of these three Ironbarks (Nos. 17-19) just here, and this is the furthest limit west on the Mountains.

20. *E. squamosa* Deane and Maiden.—In company with Mr. W. F. Blakely, a few trees were noticed about the 41-mile stone on main western road, about 2 miles west of Blaxland.

21. *E. rubida* Deane and Maiden.—Only seen at Mount Victoria in reservoir gully, and Katoomba, north of railway.

22. *E. maculosa* Baker and Smith.—First seen at Wentworth Falls, 2 miles east of the station, and all the way to Clarence.

23. *E. Dalrympleana* Maiden.—At Mount Victoria in reservoir gully, where they were fairly numerous, and at Clarence. This species seems to prefer the valleys to the higher ground. The affinity of this with *E. rubida* seems to be close. Found at Katoomba also, and at Blackheath.

24. *E. goniocalyx* F.v.M.—Seen at Lawson, Wentworth Falls, Katoomba and Mount Wilson; mostly seen a little way down the valleys. Also found at Blackheath.

25. *E. elaeophora* F.v.M.—From Wentworth Falls to Mount Victoria, though I did not find it at Blackheath, and nowhere in any number.

26. *E. viminalis* Labill.—I only came across this at Mount Wilson, where it forms splendid trees, very upright and tall, branching high, and large in diameter at the butt.

27. *E. Bauerleni* F.v.M.—Only found at Wentworth Falls on the National Pass, in the valley and under "Inspiration Point" on Lindeman's Pass. It is very restricted in distribution.

28. *E. Deanei* Maiden.—Found at Springwood at the heads of the gullies. Isolated trees on the top at Lawson. One medium-sized tree close to the railway line on the north side about 1½ miles east of Wentworth Falls railway station. They were plentiful from Wentworth Falls to under the "Three Sisters," Katoomba, in the Jamieson Valley. These latter were very fine trees.

29. *E. punctata* DC.—From Lapstone to Springwood on the top of the

range and in valley. At Wentworth Falls and the "Valley of the Waters" below the escarpment in the valley. These latter were poor specimens in growth compared with those seen at Springwood.

30. *E. Shiressii* Maiden and Blakely.—A narrow-leaved suckered form, closely allied to *E. punctata*, found by Mr. W. F. Blakely in my company half a mile east of Blaxland on disused part of old western road.

31. *E. resinifera* Sm.—Found from Lapstone to 1½ miles or so west of Springwood, and fairly numerous. This form seems to me to differ a little from that found at a lower elevation, in the fruit having more exserted valves and more pronounced rim. The whole fruit coarser.

32. *E. corymbosa* Sm.—From Lapstone to Wentworth Falls, on top of the range, thence in the Jamieson Valley to under Inspiration Point, some way between the Valley of the Waters and Leura Falls. Found again in the Megalong Valley west of the Narrow Neck towards Nellie's Glen.

33. *E. eximia* F.v.M.—From Lapstone Hill to just east of Valley Heights.

34. *E. apiculata* Baker and Smith.—Found in Jamieson Valley along Lindeman's Pass between Valley of the Waters and Leura Falls under Inspiration Point. This is of a Mallee type, about 4 to 8 feet high, very narrow leaf, the fruit resembling that of *E. radiata*. Only found in very restricted area. Neither *E. stricta* nor *E. Moorei* in the neighbourhood, or I should have suggested a possible hybrid. The diameter of trunk at 3 inches from the ground of the tallest is 2 inches. The wood white and bark smooth or slightly rough and greyish in colour at butt, becoming smooth and dirty white on branches. Sucker leaves narrow. This species, unlike *E. stricta* and *E. Moorei*, which grow mostly on top of the range, is found below the cliffs in the valley. I found a few plants on King's Tableland, Wentworth Falls. A form with truncate fruit found at reservoir, Blackheath.

Eucalypts found at different localities on the Mountains.

(c.) = common everywhere; (f.c.) = fairly common; (n.c.) = not common.

Blaxland and vicinity.

E. eugenioides (c.), *E. agglomerata* (Warrimoo, n.c.), *E. piperita* (c.), *E. micrantha* (Lapstone Hill), *E. Consideniana* (common along Western Road from 40-mile stone), *E. paniculata* (a narrow belt on Lapstone Hill), *E. crebra* (a narrow belt on Lapstone Hill), *E. siderophloia* (a narrow belt on Lapstone Hill), *E. squamosa* (a few trees about 41-mile stone), *E. punctata* (f.c. in valleys), *E. Shiressii* (Lapstone Hill, ½ mile from Blaxland), *E. resinifera* (c.), *E. corymbosa* (c.), *E. eximia* (c.).

Springwood and vicinity.

E. eugenioides (c.), *E. piperita* (c.), *E. Consideniana* (f.c.), *E. Deanei* (common round the village at heads of gullies), *E. punctata* (f.c.), *E. resinifera* (common to half a mile west of village), *E. corymbosa* (c.).

Lawson and vicinity.

E. radiata (a few isolated trees in valley north of railway), *E. eugenioides* (c.), *E. piperita* (c.), *E. altior* (common in gullies), *E. micrantha* (few trees met with), *E. Sieberiana* (c.), *E. goniocalyx* (f.c. in gullies), *E. Deanei* (uncommon, only isolated trees), *E. corymbosa* (f.c.).

Wentworth Falls and vicinity.

E. radiata (f.c.), *E. fastigata* (seen only in Jamieson Valley), *E. eugenioides* (c.), *E. ligustrina* (only seen on top of range), *E. piperita* (c.), *E. stricta* (common on edge of escarpment), *E. altior* (c.), *E. micrantha* (n.c., and only on top),

E. Sieberiana (c.), *E. maculosa* (f.c. in patches on top), *E. goniocalyx* (common on and near top of range), *E. Bauerleni* (uncommon, only in one or two patches), *E. Deanei* (very rare on top; common in valley), *E. punctata* (a few isolated trees under escarpment), *E. corymbosa* (common on top and in valley towards Leura), *E. apiculata* (rare; few clumps below escarpment and on King's Tableland).

Katoomba and vicinity.

E. Moorei (about half a mile south of Nellie's Glen and near Minne-ha-ha Falls), *E. radiata* (common), *E. fastigata* (only seen in Jamieson Valley on Leura side), *E. dives* (rare; only found one tree, on north side of railway), *E. Blaxlandi* (f.c.), *E. eugenioides* (c.), *E. piperita* (c., mostly on top), *E. stricta* (in patches on top), *E. altior* (common on top and for a short distance down), *E. micrantha* (in isolated patches on top), *E. Sieberiana* (c. on top), *E. rubida* (n.c., found on north side of railway), *E. maculosa* (f.c. on top of range), *E. Dalrympleana* (f.c. on north side of railway), *E. goniocalyx* (most common a little way down valley), *E. elaeophora* (n.c., and mostly about edge on top), *E. Deanei* (only seen in valley extending as far west as the "Three Sisters"), *E. corymbosa* (only found in Megalong Valley).

Medlow and vicinity on top of range.

E. radiata (f.c.), *E. Blaxlandi* (n.c.), *E. eugenioides* (c.), *E. piperita* (c.), *E. stricta* (common in patches), *E. altior* (common), *E. Sieberiana* (c.), *E. maculosa* (f.c.), *E. elaeophora* (only a few isolated trees).

Blackheath and vicinity, on top of range.

E. Moorei (common in patches), *E. radiata* (f.c.), *E. Blaxlandi* (common; seems to take place of *E. eugenioides*, which I have no record of having seen), *E. piperita* (c.), *E. stricta* (common in patches), *E. altior* (c.), *E. micrantha* (f.c.), *E. Sieberiana* (c.), *E. maculosa* (f.c.), *E. apiculata* (a form with truncate fruit at Reservoir), *E. Dalrympleana* (along course of creek, Govett's Walk), *E. goniocalyx* (Govett's Leap).

Mount Victoria and vicinity, on top of range.

E. Moorei (common in patches, especially towards Hartley Vale), *E. radiata* (c.), *E. dives* (uncommon; found a few trees in reservoir gully), *E. Blaxlandi* (common), *E. eugenioides* (f.c.), *E. piperita* (c.), *E. stricta* (common in patches), *E. altior* (c.), *E. micrantha* (f.c.), *E. Sieberiana* (c.), *E. rubida* (f.c.), *E. maculosa* (f.c.), *E. Dalrympleana* (common in reservoir gully), *E. elaeophora* (not common on top).

Mount Wilson and road from Bell.

E. Moorei (between Hartley Vale and Bell), *E. radiata* (c.), *E. Blaxlandi* (f.c.), *E. piperita* (c.), *E. stricta* (between Bell and Mount Wilson), *E. altior* (between Bell and Mount Wilson), *E. micrantha* (between Bell and Mount Wilson), *E. Sieberiana* (c.), *E. goniocalyx* (fine trees, common at Mount Wilson), *E. viminalis* (tall straight trees at Mount Wilson).

Clarence and vicinity.

E. coriacea (n.c.), *E. coriacea* variety (Mallee type, narrow leaf, common), *E. radiata* (common), *E. dives* (common), *E. Blaxlandi* (common about Newnes Junction), *E. eugenioides* (common from Newnes Junction east), *E. piperita* (common, especially about Newnes Junction), *E. stricta* (common), *E. micrantha* (f.c.), *E. Sieberiana* (c.), *E. maculosa* (f.c.), *E. Dalrympleana* (f.c. at Clarence), *E. fastigata* (f.c. at Clarence, but not the fine trees that are in the Jamieson Valley).

OBSERVATIONS ON *HELIX ASPERA* IN AUSTRALIA.

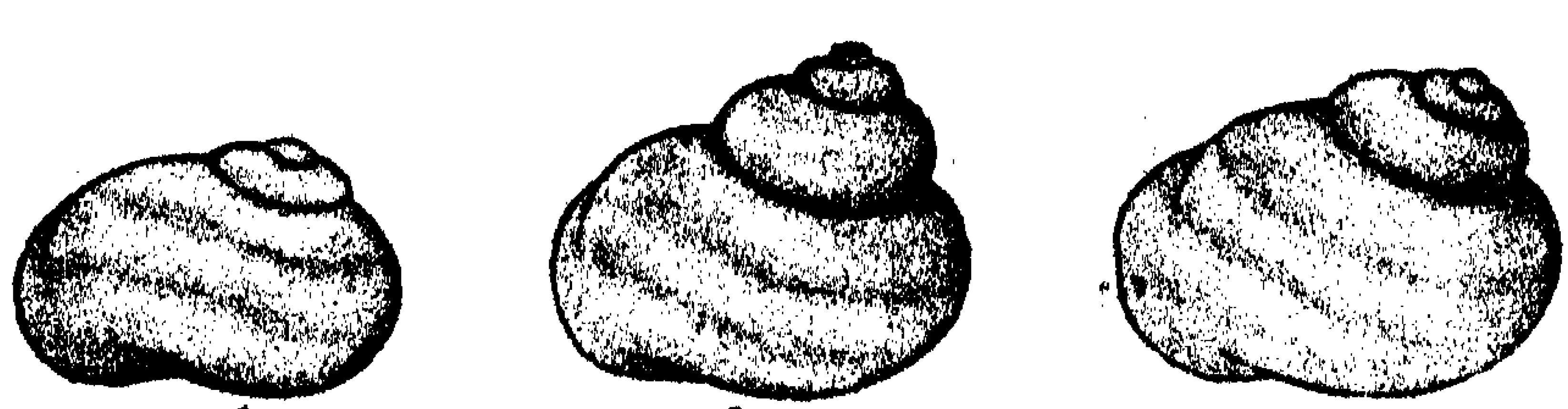
By THOS. STEEL.

(Three Text-figures.)

[Read 28th May, 1924.]

In Europe monstrosities such as sinistral and cornute forms of *Helix aspera* L. are occasionally met with and quite a number of other local forms have been described as varieties and sub-varieties. In Australia, variations are rare and the sinistral form has not so far been found. This was pointed out by Mr. John Brazier, then conchologist to the Australian Museum, in a letter published in the "Sydney Morning Herald," May 2, 1887. I can confirm Mr. Brazier's statement, for in the course of many years' observation, during which I have handled thousands of specimens in New South Wales, Victoria, South Australia and about Auckland, New Zealand, I have never met with a sinistral shell. As I have previously pointed out (These Proc., 1922, 443), in my experience in Australia and New Zealand, the shells are notably thinner, smaller and more fragile than is usually the case in Europe and may properly be identified with *H. aspera* var. *tenuior* Shuttl. Mr. C. T. Musson, of Hawkesbury Agricultural College, N. S. Wales, is quoted in J. W. Taylor's Monograph of the Land and Fresh Water Shells of the British Isles, as expressing this opinion.

Of the varieties described in the above monograph, volume on Helicidae, I have met with a few examples at Pennant Hills, near Sydney, which agree closely with those figured on Plate xxiii. as *H. aspera* var. *depressa* Paul, and also the sub-variety *punctulata* Bandon. Mr. C. Hedley agrees with me in these identi-



1. 2. 3.

fications. A specimen of var. *depressa* is shown in text-figure 1 and its dimensions are given in the table. The nearest approach to the cornute form which I have met with, is a specimen found at Pennant Hills (fig. 2) in which the spire is distinctly drawn out. Fig. 3 illustrates an associated normal example.

The largest examples of the var. *tenuior* which I have found in Australia occurred in my garden at Pennant Hills; the dimensions of these, Nos. 1 and 2 in table, agree in all but weight with Taylor's measurements for normal *H. aspera* in Europe, Nos. 9 and 10.

In Australia the shells are extremely variable in their markings, the bands varying from broad to quite narrow stripes and are frequently almost completely suppressed. The depth of coloration also varies greatly.

Following the long drought and hot spell of 1922-3, I noticed a marked diminution in the dimensions and thickness of the shells about Pennant Hills. I have taken specimens *in cop.* in March, 1923, of dimensions stated, Nos. 5 and 6 in table, one of which is remarkable for its extreme thinness and fragility as evidenced by the weight of the shell being only 0.10 gram. There was not the slightest trace of thickening of the lip. While the dimensions of the shells at this time varied somewhat, No. 6 may be taken as fairly representing the average.

I have observed a similar result from dry conditions on the development of *Peripatus* (These Proc., 1896, 96), and Professor Spencer (Horn Exped. to Cent. Aust., Part 2, 1896) relates his experience of reduction in size of mammals in Central Australia following on similar arid conditions. The before-mentioned drought of 1922-3 resulted in large numbers of individuals of *Helix* perishing, so that now, after several months showery weather, few are to be met with where formerly they were abundant. Doubtless with a continuance of favourable conditions they will soon return to their usual abundance and dimensions.

I have described the nature of the curious intermittent mucus tracks left by this shell when crawling on rough surfaces (Aust. Naturalist, iv., 1919, 97). This mollusc possesses considerable power of repairing its shell when damaged. So long as the animal is not injured and is protected from enemies, it can replace a very considerable proportion of the shell which has been removed. Snails may frequently be seen clustered about old mortar for the sake of the lime. They appear to have considerable sense of locality, for I have seen marked shells return morning after morning to the same lurking place after quite extensive feeding journeys.

Dimensions of *Helix aspera* and vars.

	1	2	3	4	5	6	7	8	9	10
Max. diam., mm.	36	35	28	27	20	25	24	28	28	35
Min. diam. ,,	27	27	24	24	16	22	22	23	25	—
Height ,,	31	29	27	26	18	25	19	27	27	35
Weight, grams	1.55	0.81	0.66	0.81	0.10	0.50	0.57	0.71	—	2.08

1 and 2. Largest specimens found in N. S. Wales—Pennant Hills.
3 and 4. Average dimensions of normal full-grown shells—Pennant Hills.
5 and 6. Specimens found *in cop.* After dry spell—Pennant Hills.
7. *H. aspera* var. *depressa*—Pennant Hills.
8. *H. aspera* approaching cornute form—Pennant Hills.
9 and 10. *H. aspera*, normal dimensions, after Taylor's monograph.

THE FOOD PLANTS OR HOSTS OF SOME FIJIAN INSECTS. Part ii.

By ROBERT VEITCH, B.Sc. and WILLIAM GREENWOOD, H.D.A.

[Read 28th May, 1924.]

Since the original article dealing with the food plants or hosts of Fijian insects was published (These Proceedings, xlvi., p. 505) a considerable number of additional records have been obtained and it is now thought desirable to publish these. Credit for the various records is made by initials as follows:—

F.M.	F. Muir.	R.V.	R. Veitch.
F.J.	F. Jepson.	W.G.	W. Greenwood.
P.B.	P. Bahr.	H.S.	H. Simmonds.
J.I.	J. Illingworth.	C.P.	C. Pemberton.

As in the previous article practically all the insect identifications have been made through the Imperial Bureau of Entomology, and credit is also due to the Sydney Botanic Gardens, Kew Gardens and the Government Botanist, Queensland, for naming numbers of the plants.

A single mark (i.) opposite an insect record indicates that that insect is of great economic importance, two marks (ii.) similarly placed classify the insect as being of some considerable importance, while three marks (iii.) indicate that, although the insect attacks economic plants, insects or animals, yet its presence in Fiji is of very little consequence: where no mark occurs it is understood that the insect in question has either not yet been recorded as attacking anything of importance in the economic life of the community or, if it has done so, the object of attack has been in a rotting or decayed condition. The economic status of each insect has been determined from Fijian records only and, if the insect in question happens to be widely distributed or cosmopolitan, has no reference to its status in other parts of the world.

LEPIDOPTERA.

The records for Lepidoptera refer to the feeding habits of the larvae.

Nymphalidae.

Deragena proserpina Butl. Feeds on the leaves of *Hoya australis* R.Br. (Asclepiadeae). W.G.

Hypolimnas bolina L. Feeds on the leaves of *Sida retusa* L. (Malvaceae). H.S.; and on the leaves of *Synedrella nodiflora* Gaertn. (Compositae). H.S.

Lycaenidae.

Catochrysops cnejus F. Feeds on the inflorescence of *Crotalaria striata* DC. (Leguminosae). R.V.

(iii.) *Jamides woodfordi* Butl. Feeds on the flowers of the following Leguminosae:—*Crotalaria striata* DC., *Phaseolus Mungo* L. and *Vigna lutea* A. Gray. All W.G.

Zizera labradus Godt. Feeds on the flowers of *Phaseolus adenanthus* Mey. (Leguminosae). W.G.

Papilionidae.

(iii.) *Papilio schmeltzi* H.S. Feeds on the leaves of the following Rutaceae:—*Citrus Aurantium* L. (R.V.), *Citrus Medica* L. var. *limonum* (H.S.) and *Micromelum pubescens* Bl. (H.S.).

Sphingidae.

(iii.) *Hippotion celerio* L. Feeds on the leaves of *Colocasia antiquorum* Schott. (Aroideae). R.V.

Zygaenidae.

(i.) *Levuana iridescens* B.B. Feeds on the leaves of *Musa sapientum* L. (Scitamineae). H.S.

Cossidae.

(ii.) *Acritocera negligens* Butl. Bores in the spathe of *Cocos nucifera* L. (Palmae). H.S.

Thyrididae.

(iii.) *Striglina superior* Butl. Feeds on the leaves of *Inocarpus edulis* Forst. (Leguminosae). R.V.

Hypsidae.

Argyna astrea Drury. Feeds on the flowers and young pods of *Crotalaria retusa* L. (Leguminosae). W.G.

Geometridae.

(iii.) *Thalassodes pilaria* Gn. Feeds on the leaves of the following:—*Inocarpus edulis* Forst. (Leguminosae), R.V.; *Mangifera indica* L. (Anacardiaceae), W.G. and *Eugenia rivularis* Seem. (Myrtaceae), W.G.

Noctuidae.

(iii.) *Achaea janata* L. Feeds on the leaves of *Ricinus communis* L. (Euphorbiaceae). R.V.

(iii.) *Anomis flava* F. Feeds on the leaves of *Hibiscus rosa-sinensis* L. (Malvaceae), R.V. and on the leaves of *Gossypium barbadense* L. (Malvaceae), H.S.

A. involuta Wlk. Feeds on the leaves of *Triumfetta rhomboidea* Jacq. (Tiliaceae). W.G.

A. vitiensis Butl. Feeds on the leaves of *Triumfetta rhomboidea* Jacq. (Tiliaceae). W.G.

(ii.) *Earias fabia* Stoll. Feeds in the flower buds of the following Malvaceae:—*Hibiscus diversifolius* Jacq. (W.G.) and *H. tiliaceus* L. (R.V.).

Hyblaea sanguinea Gaede. Feeds on the leaves of *Vitex trifolia* L. (Verbenaceae). W.G.

(iii.) *Laphygma exigua* Hübn. Feeds on the leaves of *Sorghum halepense* Pers. (Gramineae). R.V.

(ii.) *Prodenia litura* F. Feeds on the leaves of the following:—*Colocasia antiquorum* Schott. (Aroideae), R.V., *Geniostoma rupestre* Forst. (Loganiaceae), W.G., *Solanum Forsteri* L. (Solanaceae), W.G. and *Synedrella nodiflora* Gaertn. (Compositae), W.G. It also feeds on the flowers of *Acacia farnesiana* Willd. (Leguminosae). W.G.

Pyralidae.

Hymenia fascialis Cram. Feeds on the leaves of the following Amarantaceae:—*Amaranthus paniculatus* L., *A. viridis* L. and *Gomphrena globosa* L. All W.G.

(iii.) *Maruca testulalis* Hbst. Feeds on the leaves of *Inocarpus edulis* Forst. (Leguminosae), W.G. and on the pods of *Pisum sativum* L. (Leguminosae), R.V.

Psara rudis Warr. Feeds on the leaves of *Gomphrena globosa* L. (Amarantaceae). W.G.

(ii.) *Tirathaba trichogramma* Meyr. Feeds on the young nuts of *Cocos nucifera* L. (Palmae). H.S.

Pterophoridae.

Orneodes pygmaea Meyr. Feeds on the green fruits of *Vitex trifolia* L. (Verbenaceae). R.V.

Tortricidae.

(iii.) *Adoxophyes fasciculana* Wlk. Feeds on the leaves of the following Leguminosae:—*Dalbergia monosperma* Dalz., *Inocarpus edulis* Forst. and *Mucuna aterrima* Holl.; also eats the stems of the last-named species. All W.G. It also feeds on the leaves of *Citrus Medica* L., var. *limonum* (Rutaceae) and *Clerodendron inerme* R.Br. (Verbenaceae). Both W.G.

Tineidae.

Autosticha solita Meyr. Feeds on the leaves and flowers of *Nelitris vitiensis* A. Gray (Myrtaceae). W.G.

Cyathaula maculata Meyr. Feeds under the bark of dead timber. W.G.

Exelastis pumilio Zell. Feeds on the leaves and flower buds of *Alysicarpus vaginalis* DC. (Leguminosae). W.G.

(iii.) *Gracilaria soyella* Dev. Mines in the leaves of *Phaseolus calcaratus* Roxb. (Leguminosae). W.G.

Hellula undalis F. Feeds on flowers of *Gynandropsis pentaphylla* DC. (Capparideae). W.G.

Hieroxestis aurisquamosa Butl. Probably rubbish feeder †in the ripe bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

H. citrinodes Meyr. Feeds in rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

(iii.) *Idiophantis chiridota* Meyr. Breeds in ripe fruits of *Eugenia malaccensis* L. (Myrtaceae). W.G.

(iii.) *Trichophaga abruptella* Meyr. Feeds on the wool of socks. W.G.

Lyonetiidae.

Catalectis pharetropa Meyr. Feeds in the fungus *Lezites repanda* Fr. W.G.

Decadarchis heterogramma Meyr. Probably rubbish feeders in ripe bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

(iii.) *Erechthias zebrina* Burl. Feeds in pith helmets. R.V.

Gelechiidae.

Dichomeris transecta Meyr. Feeds on the leaves of *Pongamia glabra* Vent. (Leguminosae). W.G.

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† All records commencing "Probably rubbish feeder" refer to insects actually bred from bolls of *Gossypium barbadense* L., in which they were believed to be rubbish feeders and were not the cause of any unhealthy condition of the bolls.

(ii.) *Gelechia gossypiella* Saund. Feeds on the bolls of *Gossypium barbadense* L., on the seed pods of *Hibiscus tiliaceus* L. and on the flower buds of *Thespesia populnea* Soland. All Malvaceae and credited to H.S.

(iii.) *Pachnistis solita* Meyr. Feeds in the stored seed of *Zea Mays* L. (Gramineae). R.V.

(ii.) *Phthorimaea heliopa* Lower. Tunnels in the stems of *Nicotiana Tabacum* L. (Solanaceae). H.S.

Rhadinophylla siderosema Turn. Attacks leaves of *Pongamia glabra* Vent. (Leguminosae). W.G.

(ii.) *Sitotroga cerealella* Ol. Feeds in the seeds of *Zea Mays* L. (Gramineae). R.V.

Eucosmidae.

(iii.) *Argyroploce aprobola* Meyr. Feeds on the young leaves of *Mangifera indica* L. (Anacardiaceae). W.G.

Eucosma defensa Meyr. Feeds on the leaves of the following Leguminosae:—*Dalbergia monosperma* Dalz. and *Pongamia glabra* Vent. Both W.G.

E. eumarodes Meyr. Feeds on the leaves of *Nelitris vitiensis* A. Gray (Myrtaceae). W.G.

Phyllorycteridae.

Acrocercops habroscia Meyr. Feeds in galls on the leaves of *Calophyllum Inophyllum* L. and *C. vitiense* Turrill. (Guttiferae). Both W.G.

A. macroclina Meyr. Tunnels in the leaflets of *Caesalpinia bonducella* Flem. (Leguminosae). W.G.

(iii.) *Cyphosticha caerulea* Meyr. Tunnels in the leaves of the following Leguminosae:—*Phaseolus adenanthus* Mey., *P. vulgaris* L. and *Vigna lutea* A. Gray. All W.G.

Liocrobyla paraschista Meyr. Tunnels in the leaflets of *Caesalpinia bonducella* Flem. (Leguminosae). W.G.

Cosmopterygidae.

Labdia allotriopa Meyr. Probably rubbish feeders in the bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

L. calida Meyr. Probably rubbish feeder in the bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

L. clytemnestra Meyr. Feeds in dead twigs of *Mangifera indica* L. (Anacardiaceae). W.G.

L. epizona Meyr. Probably rubbish feeder in the bolls of *Gossypium barbadense* L. (Malvaceae). W.G.

Limnoecia inconcinna Meyr. Probably rubbish feeder in the bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

Pyroderces euryspora Meyr. Probably rubbish feeder in bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

Heliodinidae.

Stathmopoda synchrysa Meyr. Probably rubbish feeder in the bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

Coleophoridae.

(ii.) *Agonoxena argaula* Meyr. Feeds on the leaves of *Cocos nucifera* L. (Palmae). H.S.

Coleophora immortalis Meyr. Feeds on flowers of *Amaranthus paniculatus* L. (Amarantaceae). W.G.

Olethreutidae.

(iii.) *Crocidosema plebeiana* Zell. Feeds in ripe fruits of *Eugenia malaccensis* L. (Myrtaceae). W.G.

Spilonota cryptogramma Meyr. Feeds on the flowers of *Nelitris vitiensis* A. Gray (Myrtaceae). W.G.

S. holotephras Meyr. Feeds on the young leaves of *Psidium Guayava* L. (Myrtaceae). R.V.

Galleriidae.

(iii.) *Corcyra cephalonica* Stn. Feeds in the seed of *Zea Mays* L. (Gramineae). R.V.

Sparganothidae.

Acroclita physalodes Meyr. Feeds in flowers of *Barringtonia speciosa* L.f. (Lecythidaceae). W.G.

COLEOPTERA.

The stage in which the damage is done is noted in all the records for Coleoptera because in some cases the attack is the work of the larva, in other cases of the imago and in two instances of both larva and imago.

Dytiscidae.

(ii.) *Cybister tripunctatus* Ol. Larva and imago are predaceous on the larvae and pupae of Culicidae. R.V.

Rutelidae.

(ii.) *Adoretus versutus* Har. Imago feeds on the leaves of *Bougainvillea spectabilis* Willd. (Nyctaginaceae), R.V. and *Poinciana regia* Boj. (Leguminosae), R.V.

Cetoniidae.

(iii.) *Protaetia fusca* Herbst. Imago feeds on the green pods of *Crotalaria striata* DC. (Leguminosae). R.V.

Nitidulidae.

Haptoncus tetragonus Murr. Larvae feed on the rotten fruits of the following plants:—*Citrus decumana* Murr., *C. Medica* L. var. *limonum* (Rutaceae), and *Spondias dulcis* Willd. (Anacardiaceae). All W.G.

Trogositidae.

(ii.) *Lophocateres pusillus* Klug. Larvae feed in stored seeds of *Zea Mays* L. (Gramineae). R.V.

Coccinellidae.

(ii.) *Scymnus fijiensis* Sic. Larva and imago feed on Coccidae generally. R.V.

Dermestidae.

(ii.) *Anthrenus pimpinellae* F. Larvae feed on felt in pianos. R.V.

Bostrychidae.

(iii.) *Xylothrips religiosus* Boisd. Larvae feed in the branches of *Inocarpus edulis* Forst. (Leguminosae). R.V.

Rhipiceridae.

Callirrhipis vitiensis Fairm. Larvae breed in rotten timber. R.V.

Tenebrionidae.

(ii.) *Tribolium confusum* Jacq.-Duv. Larvae feed on dried moths in insect collections. R.V.

Galerucidae.

(ii.) *Aulacophora quadrimaculata* F. Larvae eat the flowers of *Luffa aegyptiaca* Mill. (Cucurbitaceae). W.G.

Anthribidae.

(ii.) *Araecerus fasciculatus* de G. Larvae feed in the ripe pods of *Acacia farnesiana* Willd. (Leguminosae), R.V. and in the dry fruits of *Jatropha Curcas* L. (Euphorbiaceae), W.G.

Curculionidae.

(i.) *Rhabdocnemis obscura* Boisd. Larvae tunnel in the base of the leaves of *Cocos nucifera* L. (Palmae). F.J.

Scolytidae.

Cryphalus jatrophae Samp. Larvae feed in dry fruits of *Jatropha Curcas* L. (Euphorbiaceae). W.G.

Hypothenemus gossypii Samp. Probably rubbish feeder in bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

H. plumeriae Nord. Larvae feed in the ripe pods of *Acacia farnesiana* Willd. (Leguminosae). R.V.

(iii.) *Xyleborus torquatus* Eichh. Larvae feed in stalks of *Saccharum officinarum* L. (Gramineae). R.V.

HYMENOPTERA.

The records for Hymenoptera refer to the feeding habits of the larva.

Dryinidae.

(ii.) *Haplogonotopus vitiensis* Perk. Attacks the nymph of *Perkinsiella vitiensis* Kirk. (Asiracidae). F.M.

Mymaridae.

(ii.) *Paranagrus optabilis* Perk. Attacks the eggs of *Perkinsiella vitiensis* Kirk. (Asiracidae). F.M.

Pteromalidae.

(ii.) *Aplastomorpha calandrae* How. Attacks the immature stages of *Calandra oryzae* L. (Curculionidae). R.V.

(ii.) *A. vandinei* Tuck. Attacks the immature stages of *Calandra oryzae* L. (Curculionidae). R.V.

(ii.) *Bruchobius laticeps* Ashm. Attacks immature stages of *Bruchus chinensis* L. (Bruchidae). R.V.

Eulophidae.

(i.) *Aphelinus chrysomphali* Mercet. Attacks *Aspidiotus destructor* Sign. var. *transparens* Green (Coccidae). H.S.

(i.) *Aspidiotiphagus citrinus* Craw. Attacks *Aspidiotus destructor* Sign. var. *transparens* Green (Coccidae). H.S.

Trichogrammatidae.

(i.) *Chaetostricha cratitia* Waterst. Attacks the eggs of *Promecotheca reichei* Baly. (Hispidae). H.S.

Braconidae.

(iii.) *Apanteles expulsus* Turn. Attacks the larvae of *Cirphis unipuncta* Haw. (Noctuidae). R.V.

Eumenidae.

Eumenes ovalauensis Sauss. Feeds in mud cells on larvae of *Thalassodes pilaria* Gn. (Geometridae). W.G.

Sphegidae.

Pison ignavum Turn. Feeds in mud nests on paralysed Attid spiders. R.V.

Scoliidae.

(ii.) *Scolia manilae* Ashm. Feeds on the larvae of *Adoretus versutus* Har. (Rutelidae). R.V.

HEMIPTERA.

Practically all the records for the Hemiptera refer to the feeding habits of the nymph and imago, but in the Coccidae the male imago has aborted mouth parts and so cannot suck plant juices.

Pentatomidae.

(iii.) *Alciphron glaucus* F. Feeds on flower buds and fruits of *Passiflora quadrangularis* L. (Passifloreae). R.V.

(ii.) ***Brachyplatys pacificus*** Dall. Feeds on the leaves and stems of the following Leguminosae:—***Cajanus indicus*** Spreng. (W.G.), *Phaseolus semierectus* L. (R.V.) and ***Pongamia glabra*** Vent. (W.G.). Also similarily attacks *Hibiscus tiliaceus* L. (Malvaceae). W.G.

(iii.) *Tectocoris lineola* F. Feeds on the leaves, young shoots and buds of the following Malvaceae:—*Gossypium barbadense* L. and *Thespesia populnea* Soland. Both H.S.

Coreidae.

(iii.) *Mictis profana* F. Feeds on young shoots of *Citrus Aurantium* L. (Rutaceae). H.S.

Miridae.

(i.) *Cyrtorhinus mundulus* Bred. Sucks the contents of the eggs of *Perkinsiella vitiensis* Kirk. (Asiracidae). C.P.

Pyrrhocoridae.

(ii.) *Dysdercus impictiventris* Stal. Feeds on the leaves, young shoots and flower buds of the following Malvaceae:—*Sida acuta* Burm., *S. retusa* L. and *Thespesia populnea* Soland. All H.S.

(ii.) *D. insularis* Stal. Feeds on the leaves, young shoots and flower buds of the following Malvaceae:—*Sida acuta* Burm., *S. retusa* L. and *Thespesia populnea* Soland. All H.S.

Capsidae.

(ii.) *Dicyphus minimus* Uhler. Feeds on the leaves of *Nicotiana Tabacum* L. (Solanaceae). F.J.

Gallobelicus crassicornis Dist. Feeds on leaves of *Gynandropsis pentaphylla* DC. (Capparideae). W.G.

Tetigoniidae.

Nesosteles glauca Kirk. Feeds on the inflorescence of the following Gramineae:—*Panicum barbinode* Trin. and *Paspalum dilatatum* Poir. W.G.

N. hebe Kirk. Feeds on the inflorescence of the following Gramineae:—*Amphilophis glabra* Stapf, *Paspalum dilatatum* Poir. and *Tricholaena rosea* Nees. All R.V.

Fulgoridae.

Urvillea melanesica Kirk. Feeds on the leaves and stems of *Vitex trifolia* L. (Verbenaceae). R.V.

Psyllidae.

Leptynoptera didactyla Laing. Feeds on the leaves of *Calophyllum Inophyllum* L. (Guttiferae). W.G.

Nesiope ornata Kirk. Feeds on the leaves of *Heritiera littoralis* Dryand. (Sterculiaceae). W.G.

Aphidae.

(ii.) *Aphis gossypii* Glover. Feeds on the young shoots, leaves and flower buds of the following:—*Gossypium barbadense* L. (Malvaceae), H.S.. *Hibiscus rosa-sinensis* L. (Malvaceae), R.V., *Phaseolus calcaratus* Roxb (Leguminosae), W.G. and *Psidium Guayava* L. (Myrtaceae), R.V.

Aleurodidae.

(iii.) ***Aleurodes comata*** Mask. Feeds on the leaves of the following Gramineae:—*Miscanthus japonicus* Anderss. (R.V.) and ***Thuarea involuta*** R.Br. (W.G.).

(iii.) ***Bernisia inconspicua*** Quaint. Feeds on the leaves of ***Colocasia antiquorum*** Schott. (Aroideae). R.V.

Coccidae.

(ii.) *Aspidiotus cocotis* Newst. Feeds on *Cocos nucifera* L. (Palmae). H.S.

(i.) *A. destructor* Sign. var. *transparens* Green. Feeds on the leaves of *Anona reticulata* L. (Anonaceae). W.G.

(ii.) *A. palmae* Ckll. Feeds on *Cocos nucifera* L. (Palmae). H.S.

Ceroplastes rubens Mask. Attacks *Barringtonia speciosa* L.f. (Lecythidaceae). R.V.

(ii.) *Chrysomphalus* (*Aspidiotus*) *aurantii* Mask. Feeds on *Cocos nucifera* L. (Palmae). H.S.

C. dictyospermi Morg. Attacks the leaves of *Alpinia nutans* Rosc. (Scitamineae). W.G.

(ii.) *Coccus hesperidum* L. Attacks the following Rutaceae:—*Citrus Aurantium* L., *C. Aurantium* L. var. *nobilis* and *Citrus Medica* L. var. *limonum.* Also attacks *Cocos nucifera* L. (Palmae). All H.S.

(ii.) *Hemichionaspis minor* Mask. Feeds on the following:—*Cocos nucifera* L. (Palmae), H.S., *Dodonaea viscosa* Jacq. (Sapindaceae), W.G., *Gossypium barbadense* L. (Malvaceae), H.S. and *Inocarpus edulis* Forst. (Leguminosae), R.V.

(iii.) *Icerya purchasi* Mask. Attacks the following:—*Cassia fistula* L. (Leguminosae), W.G., *Casuarina equisetifolia* Forst. (Casuarinaceae), W.G., *Inocarpus edulis* Forst. (Leguminosae), R.V. and *Premna taitensis* Schauer. (Verbenaceae), W.G.

(iii.) *I. seychellarum* Westw. Feeds on the following:—*Hibiscus rosa-sinensis* L. (Malvaceae), R.V. and *Psidium Guayava* L. (Myrtaceae), W.G.

Lecanium hemisphaericum T.T. Attacks *Graptophyllum pictum* L. (Acanthaceae). W.G.

L. viride Green. Attacks *Dodonaea viscosa* L. (Sapindaceae), W.G. and *Psidium Guayava* L. (Myrtaceae), R.V.

(iii.) *Paleococcus rosae* Ril. and How. Attacks *Rosa* sp., Garden variety (Rosaceae). R.V.

(iii.) *Pseudococcus citri* Risso. Attacks the young pods of *Acacia farnesiana* Willd. (Leguminosae), W.G., the leaves of *Clerodendron fallax* Lindl. (Verbenaceae), R.V., the leaves and stem of *Ficus Barclayi* Seem. (Urticaceae), W.G. and the leaves of ***Inocarpus edulis*** Forst. (Leguminosae), R.V.

(ii.) *P. vitiensis* Green and Laing. Attacks *Cocos nucifera* L. (Palmae). R.V.

(iii.) *Saissetia nigra* Nietn. Attacks the following:—***Gossypium barbadense*** L. (Malvaceae), H.S., ***Hibiscus rosa-sinensis*** L. (Malvaceae), R.V., ***Pandanus odoratissimus*** L. (Pandanaceae), W.G., ***Panicum distachyum*** L. (Gramineae), W.G. and ***Psidium Guayava*** L. (Myrtaceae), R.V.

(iii.) ***Vinsonia stellifera*** Westw. Attacks ***Mangifera indica*** L. (Anacardiaceae). R.V.

ORTHOPTERA.

The records for the Orthoptera refer to the feeding habits of both nymph and imago.

Forficulidae.

(ii.) *Chelisoches morio* F. Feeds on insects generally. R.V.

Blattidae.

(ii.) *Leucophaea surinamensis* L. Omnivorous on dead animal and vegetable matter. R.V.

(i.) *Periplanata australasiae* F. Omnivorous on dead animal and vegetable matter. R.V.

(ii.) *Phyllodromia notulata* Stal. Omnivorous on dead animal and vegetable matter. R.V.

Acridiidae.

(iii.) *Aeolopus tamulus* F. Feeds on Gramineae generally. R.V.

NEUROPTERA.

Chrysopidae.

(ii.) *Chrysopa sanvitoresi* Nav. The larvae feed on Aphids generally, W.G., and on the eggs of *Prodenia litura* F. (Noctuidae). R.V.

Libellulidae.

(ii.) *Pantala flavescens* F. Larva and imago predaceous on insects, more especially Dipterous larvae, pupae and imagines. R.V.

DIPTERA.

Culicidae.

(iii.) *Rachionotomyia purpurata* Edw. Attacks human beings in the female imaginal stage. P.B.

Tipulidae.

Libnotes greenwoodi Alex. Larvae feed in the fruits of *Eugenia malaccensis* L. (Myrtaceae). W.G.

Syrphidae.

(iii.) *Xanthogramma grandicorne* Meq. Larvae feed on *Aphis gossypii* Glover (Aphidae). R.V.

Piophilidae.

(ii.) *Piophila casei* L. Larvae feed in cheese. R.V.

Trypetidae.

Dacus xanthodes Broun. Larvae feed in fruits of *Citrus decumana* Murr. (Rutaceae). J.I.

Agromyzidae.

(ii.) *Agromyza lantanae* Frogg. Larvae feed in the berries of *Lantana Camara* L. (Verbenaceae). F.J.

Muscidae.

(i.) *Musca domestica* L. Larvae feed in the rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

STUDIES IN THE EPACRIDACEAE.

i. The Life-History of Styphelia longifolia (R.Br.).

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(*From the Botanical Laboratory of the University of Sydney*).

(Thirty-one Text-figures.)

[Read 30th April, 1924.]

In a preliminary note (1923) the writer gave a brief account of certain striking features regarding megasporogenesis and the embryo-sac of *Styphelia longifolia* (R.Br.). A general account of the classification and distribution of the Epacridaceae was also given, together with a description of the external morphology of the genus *Styphelia*. A detailed study of the more important phases in the life-history of *S. longifolia* is now presented.

Habitat.

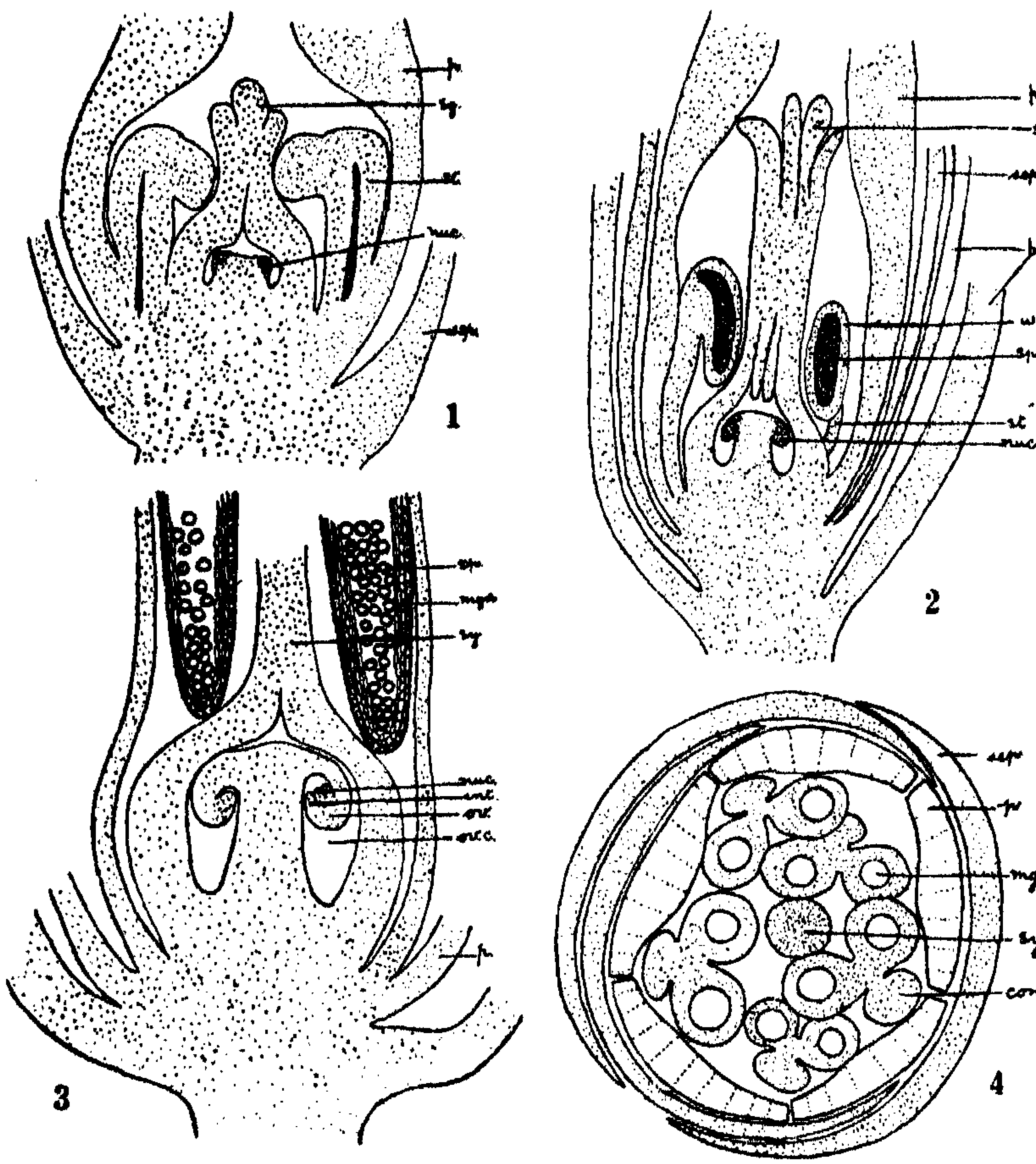
A careful study of *Styphelia longifolia* in the field has revealed the fact, that this species only flourishes when surrounded and sheltered by dense bush consisting of plants which attain a relatively greater height such as species of *Banksia, Grevillea, Petrophila, Xylomelum, Isopogon,* and *Eucalyptus*. The species in question does not thrive in open exposed situations. It may be found in such sites, but is then a remnant consequent on clearing operations. The soil in which it grows is of a light sandy nature such as typically overlies the Hawkesbury sandstone. It would seem then, that although the plant is adapted to live in a dry porous soil, it none the less is unable to withstand the dry winds of an isolated exposed position.

Another noteworthy fact is, that while a considerable number of plants may be found per acre of bush, still they are almost always separated from one another by other plants of the genera already referred to. This isolation of the individual plant, considered in conjunction with the succulence and size of the drupe, has suggested to the writer that animals, chiefly birds, are the final agents in dissemination.

The Flower.

The essentials of the floral morphology of *Styphelia longifolia* have already been described (1923). In Text-fig. 1 the relative positions of the floral elements on the thalamus in the young flower bud are represented. In the gynoecium two of the five loculi are depicted, and in each the nucellus is represented by a knob-like mass of tissue. Surmounting the ovary is the style, terminated in turn by a slightly lobed stigma.

Inserted below the gynoecium are the stamens, two of which are represented. These do not yet show the clear differentiation into anther and filament which is so evident in the more mature stamen (Text-fig. 3). Even at this early stage, however, sporogenous cells are present within the young microsporangium. Be-



Text-fig. 1.—A median longitudinal section of a young flower bud, showing the stage of development and relative size of the parts. (sep.) sepal, (p.) petal, (st.) stamens, (sg.) stigma, (nuc.) nucellus. (x 110).

Text-fig. 2.—A median longitudinal section of a bud slightly older than that of Text-fig. 1. (br.) bract, (sep.) sepal, (p.) petal, (st.) stamen, (spor.) sporogenous tissue, (w.) wall of microsporangium, (sg.) lobed stigma, (nuc.) naked nucellus. (x 110).

Text-fig. 3.—A median longitudinal section of a still older bud. Thick-walled microspores (sp.) are shown within the microsporangium (mgn.). The young anatropous ovule (ov.), shows the nucellus (nuc.) and single integument (int.). (ov.c.) ovary cavity, (sy.) style, (p) petal. (x 110).

Text-fig. 4.—T.S. of flower bud about the same age as that in Text-fig. 2. (sep.) sepal, (p.) petal, (mgn.) microsporangium, (con.) connective, (sy.) style. The anther is seen to consist of two microsporangia, and the stamens alternate with the petals.

low the andreecium the petals are inserted and these in turn are ensheathed by sepals and numerous bracts.

A slightly older stage is represented in Text-fig. 2. The nucellus is now assuming the curved form which anticipates the anatropous condition of the mature ovule. No integument has yet made its appearance. The microsporangium shows a differentiation into wall, tapetum, and sporogenous tissue, while the style has elongated and the stigma become more distinctly lobed. The non-essential organs have grown in proportion.

A still older bud is presented in Text-fig. 3. The anatropous nature of the ovule, which is at the spore mother cell stage, is clearly evinced. The ovary cavity is relatively large, and remains so until maturity is almost attained. Thus the young ovule has plenty of room in which to increase in size. In one of the ovules, the single massive integument and the nucellus are clearly differentiated. The integument, however, is still far from completely enclosing the nucellus. Numerous microspores with very thick walls are present in each of the microsporangia.

A transverse section of a bud of the same age as that figured in Text-fig. 2 is delineated in Text-fig. 4. On the outside are seen three of the sepals which ensheath the five lobes of the young corolla. In front of the petals, and alternating with them, are the five stamens. Each anther is composed of only two microsporangia and the supporting connective. The centre of the bud is occupied by the style.

This then gives an idea of the gross morphology of the flower in the young bud stage.

Microsporangium.

The stamen of the Epacridaceae is remarkable in that the anther consists of only two microsporangia, in place of the four usually found in Angiosperms.

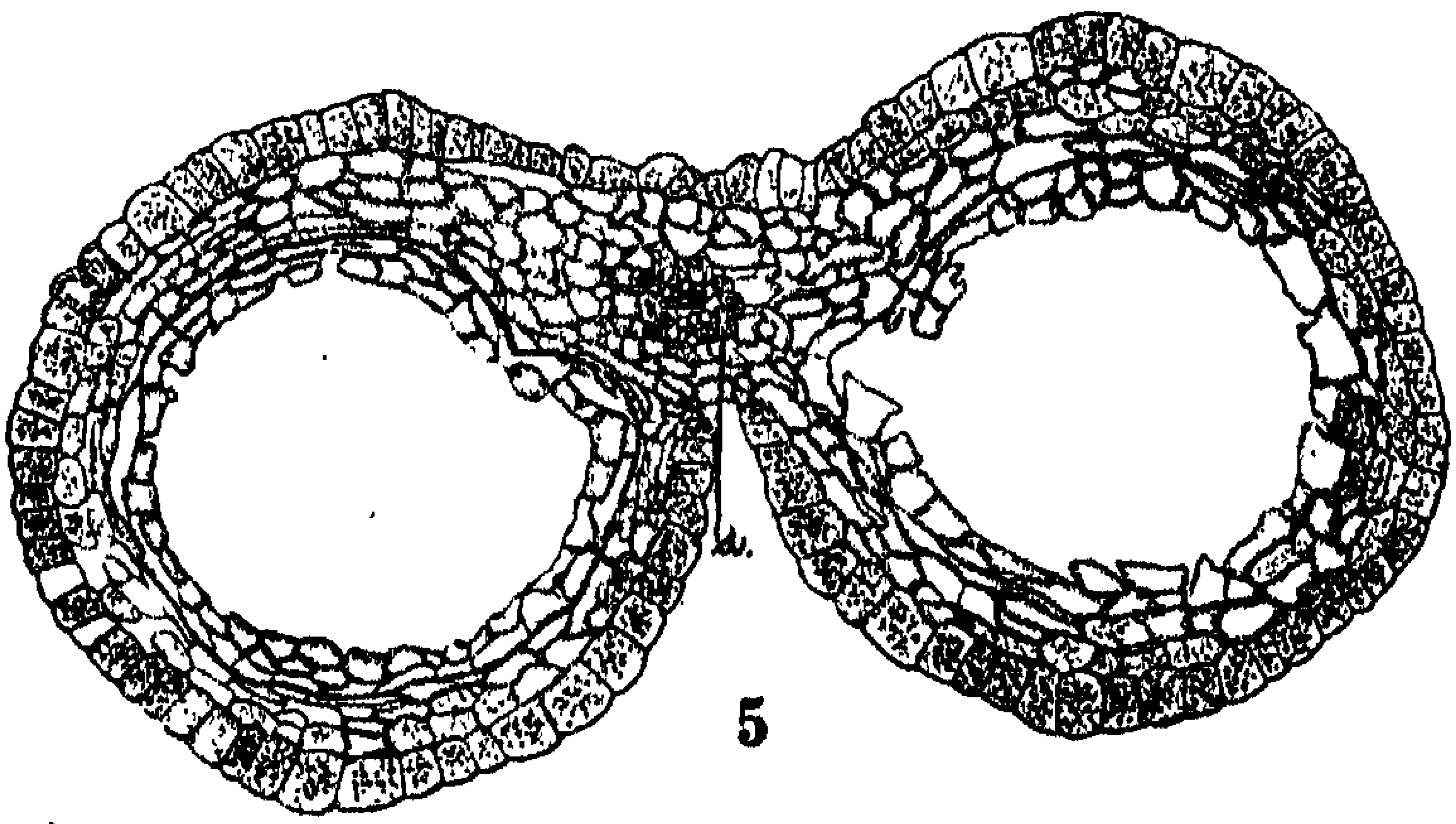
In addition it displays a longitudinal dehiscence in striking contrast to the poricidal or apical fissure method characteristic of the Ericaceae. The two microsporangia and connective are represented in Text-fig. 5, which shows a transverse section of an immature anther taken when the flower bud is at the stage indicated in Text-fig. 3.

One of these microsporangia at a higher magnification is presented in Text-fig. 6. The uninucleate microspores are provided with enormously thick stratified walls. The tapetum (*t*) is still quite visible, although somewhat depleted. The wall of the sporangium is several cells thick, and the cells adjacent to the tapetum are appreciably compressed in a radial direction. The epidermis of the anther is composed for the most part of relatively larger square-shaped cells containing numerous tannin granules. It is to be noted that these epidermal cells steadily decrease in size as the region of dehiscence (*d*), on the anterior side of the anther, is approached, and that separating the two sporangia is an area of thin walled sterile cells.

When the petals begin to open, the filament quickly elongates, while the anther speedily reaches its mature proportions. Examination of a transverse section of an exserted anther shows the mature pollen grains in the bi-nucleate condition (Text-fig. 7).

The microspore has now reached its full size, and its cell walls are much thinner than those depicted in Text-fig. 6. At this stage numerous globules of a yellow oily substance make their appearance on the outer surface of the exine, thus imparting a stickiness to the pollen grains, which facilitates their conveyance from one flower to another.

No doubt the thick stratified walls of the younger microspores represent a reserve store of cellulose which is drawn upon during the rapid development which precedes the production of the mature spores. The tapetum has become disorganised and some of the wall cells have also suffered. While this is going



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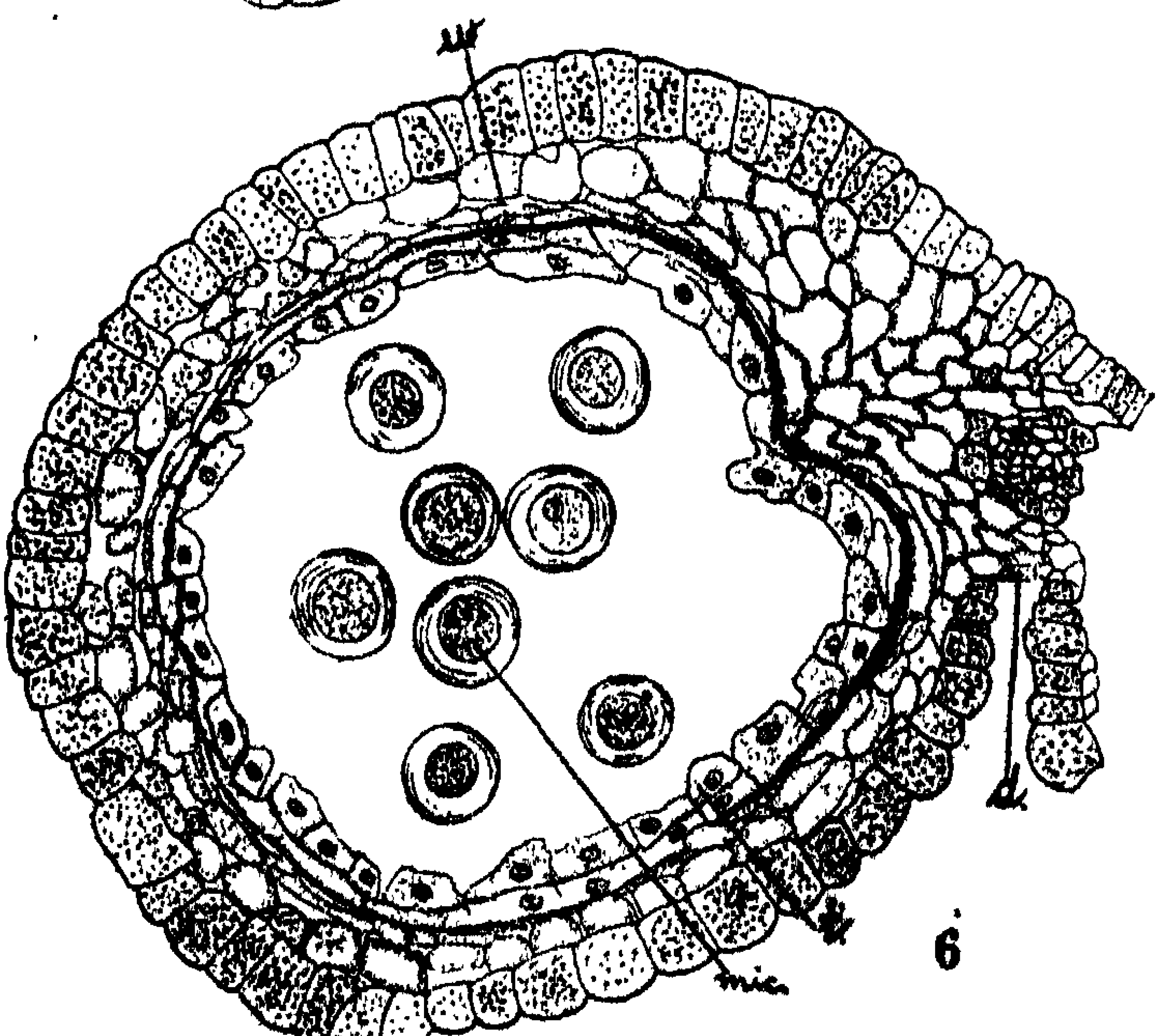

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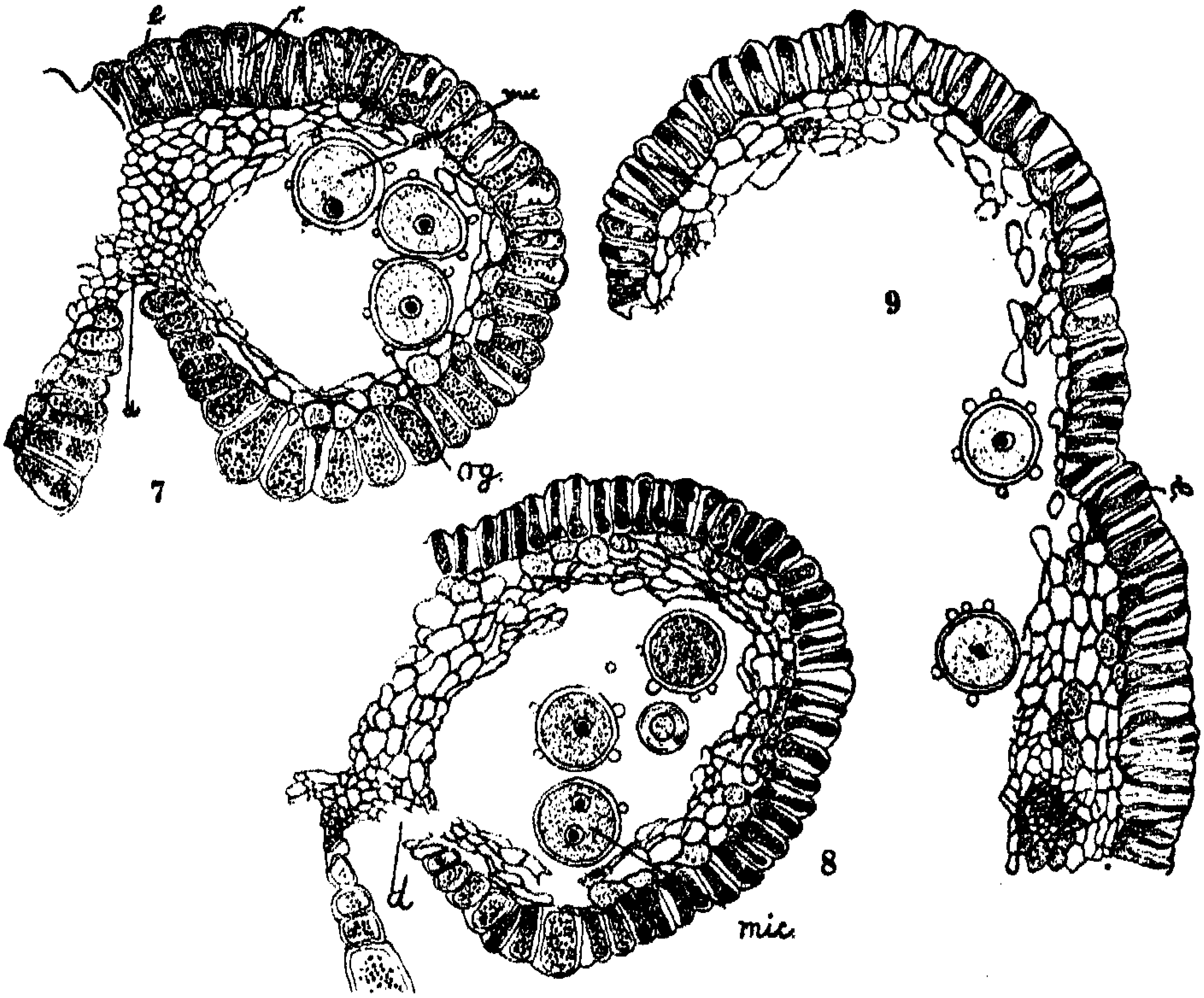
Text-fig. 5.—A transverse section of a young anther taken from a flower bud at the same stage of development as that illustrated in Text-fig. 3. The two microsporangia of the anther are shown. (x 225).

Text-fig. 6.—A transverse section of one of the above microsporangia under a higher magnification. The thick striated walls of the uni-nucleate microspores (mic.), the tapetum (t.) and the compressed cells of the sporangial walls (w.) are indicated. The cells of the epidermis decrease in size as the region (d.) is approached. Numerous grains of tannin are seen within the epidermal cells. (x 270).

on, the walls of the epidermis undergo a remarkable change owing to excessive thickening of the radial walls. The periclinal walls also share in this, but to a much less extent.

It is noteworthy that this thickening of the epidermal walls is interrupted at the region (*d*) adjoining the vascular bundle. This feature is important because on that modification in structure the method of dehiscence largely depends.



Text-fig. 7.—A transverse section of a microsporangium at a later stage. The walls of the enlarged microspores (mic.) are now much thinner, and the tapetum is no longer visible. Thickening of the radial walls (r.) of the epidermal cells is pronounced while the tangential walls have also increased somewhat in thickness. The width of each epidermal cell is greatest at the periphery. The thickening of the cell walls of the epidermis becomes less pronounced as the region (d.) is approached. Oil globules (og.) are present on the surface of the microspores. (x 110).

Text-fig. 8.—A transverse section of a microsporangium showing the initiation of the slit of dehiscence. The thickened cells of the epidermis are compressed tangentially, and the thin-walled tissue at (d.) has been ruptured. The microspores (mic.), with one exception, are fully developed and in the bi-nucleate condition. (x 110).

Text-fig. 9.—A transverse section of a mature microsporangium showing the final stage in dehiscence. The slit of dehiscence is fully distended, and nearly all the pollen grains have been shed. The thickening of the radial walls of the epidermal cells is very pronounced. (x 110).

Dehiscence.

After the stamen has reached maturity, the ensuing desiccation leads to a contraction throughout the cells of the sporangial walls. The epidermal cells

naturally share in the resultant tension, which steadily increases until rupture occurs, as indicated in Text-fig. 8. Examination shows that this occurs at the only region at which the cells are unthickened, and, as is to be expected, the tissue gives way along the line of least resistance (Text-fig. 8). Not only that, but the extent and direction of the rupture are controlled by the ring of cells with specially thickened walls surrounding the vascular bundle of the connective (Text-fig. 6). The aperture thus initiated steadily increases in size until the condition represented in Text-fig. 9 is reached. The dispersal of the microspores then follows as a matter of course.

An examination of the microsporangia at different stages (Text-figs. 5-9) demonstrates how the various specialised structures combine to effect a common purpose, namely, the rupture of the sporangium, to set free the spores.

The epidermal layer, which to begin with has cell walls of normal thickness, gradually acquires a thickening of the radial walls, and to a much less extent of the periclinal walls (Text-fig. 7). This increases until the extremely thick radial walls shown in Text-fig. 8 are produced. The outer walls of the epidermal cells are slightly thicker than the inner walls. Accordingly, when contraction due to desiccation occurs, the specialised structure of the epidermal cells permits of tangential compression, but resists radial pressure. This naturally produces a tangential strain, resulting in the rupture of the thin walled cells at (*d*), and the gradual pulling apart of the arms of the sporangia. The opening outwards of these arms brings the outer ends of the radial walls closer together, and so produces the wrinkled appearance seen in profile in Text-fig. 9. The change in shape of the epidermal cells is manifest on comparing Text-fig. 7 at (*e*) with Text-fig. 9 at (*e*). The inner tangential walls are thin, and therefore well adapted to permit of the change in shape which the individual cells of the epidermis undergo, when dehiscence is complete.

Microsporogenesis in *Styphelia longifolia* is at present under investigation and will be described in a subsequent paper.

The Ovule.

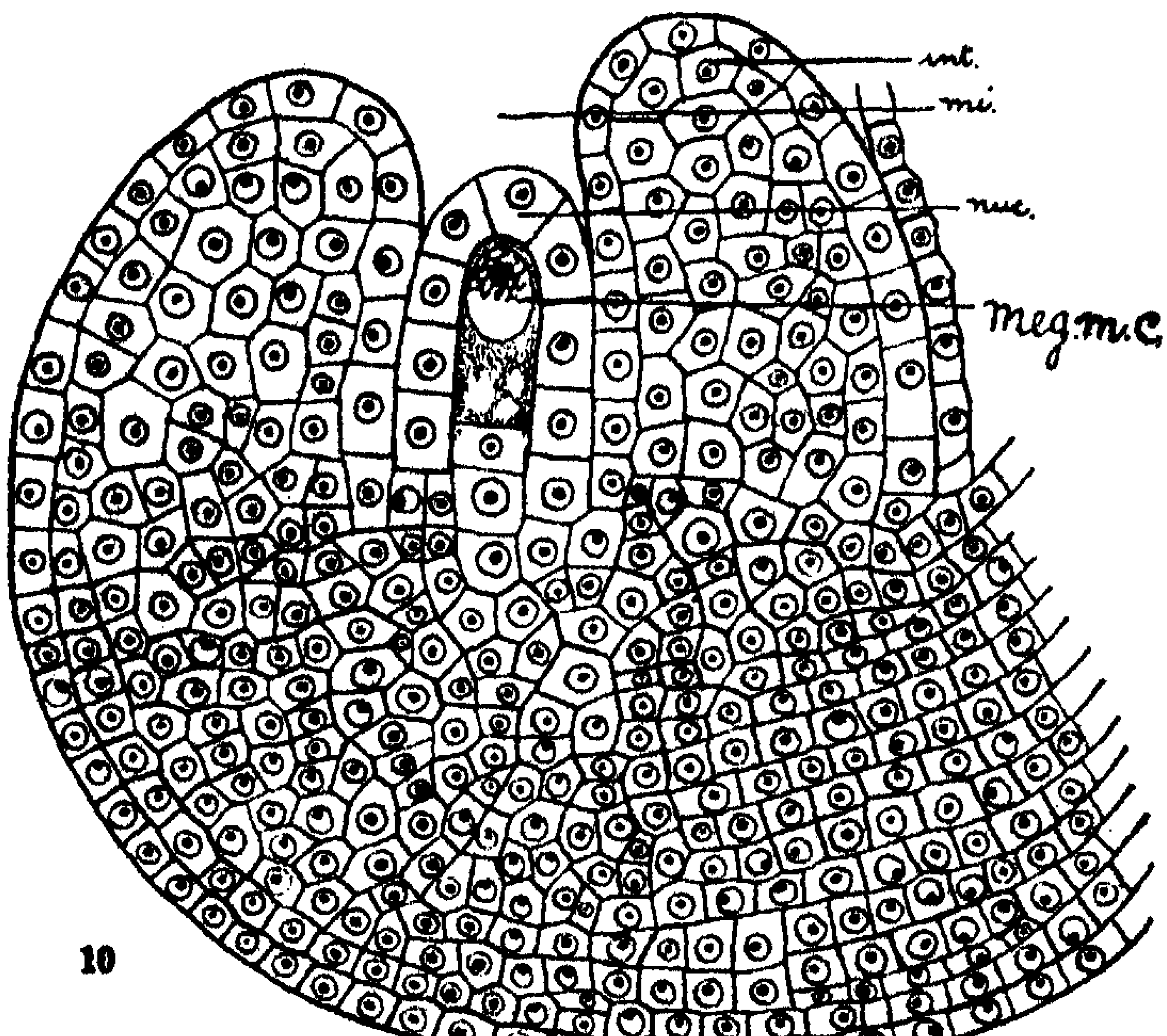
The young ovule consists of a slender nucellus surrounded by a single thick integument. In Text-fig. 10 the relative positions and sizes of these parts are illustrated. The megasporangium proper consists of a single axial row of cells enclosed by an epidermis one cell thick.

Megasporogenesis.

The apical cell of this axial row enlarges and functions as a megaspore mother cell. The enlarged nucleus is very apparent, and the balled condition of the chromatin threads indicates the imminence of reduction division. No parietal cell formation occurs, and so the megaspore mother cell is only separated from the micropyle by a single layer of cells. A subsequent stage is seen in Text-fig. 11, where the four-nucleate condition, resulting from division of the mother cell, is depicted. These nuclei are very large, and are not separated from one another by walls. It seems clear then that the nucleus of the spore mother cell divides into two, and then into four, in the normal way. Later, each of the three inner nuclei becomes surrounded by cytoplasm and a thin membraneous wall, so that four complete megaspores are evolved. All four megaspores are thus enclosed within the original cell wall of the spore mother cell (Text-fig. 11).

So far then the history of megasporogenesis approximates to that characteristic of the more advanced Angiosperms. From this point, however, certain

phases of the development are evinced, which give to this life-history an interest peculiarly its own. All the megaspores continue to enlarge, but the functional megaspore is the distal or micropylar one, and not the chalazal one, as is usually the case. This rare feature is illustrated in Text-fig. 15. The occasional functioning of the micropylar megaspore in the Sympetalae was reported as far back as 1888 by Oliver. Later, other investigators, Fry (1902), Vesque (1878, 1879), Lloyd (1902), and Guignard (1882) described examples in which megaspores other than the chalazal one may occasionally function, but it should be noted that the case reported by Oliver is the only one in the Sympetalae in which it has been clearly established that the micropylar megaspore normally



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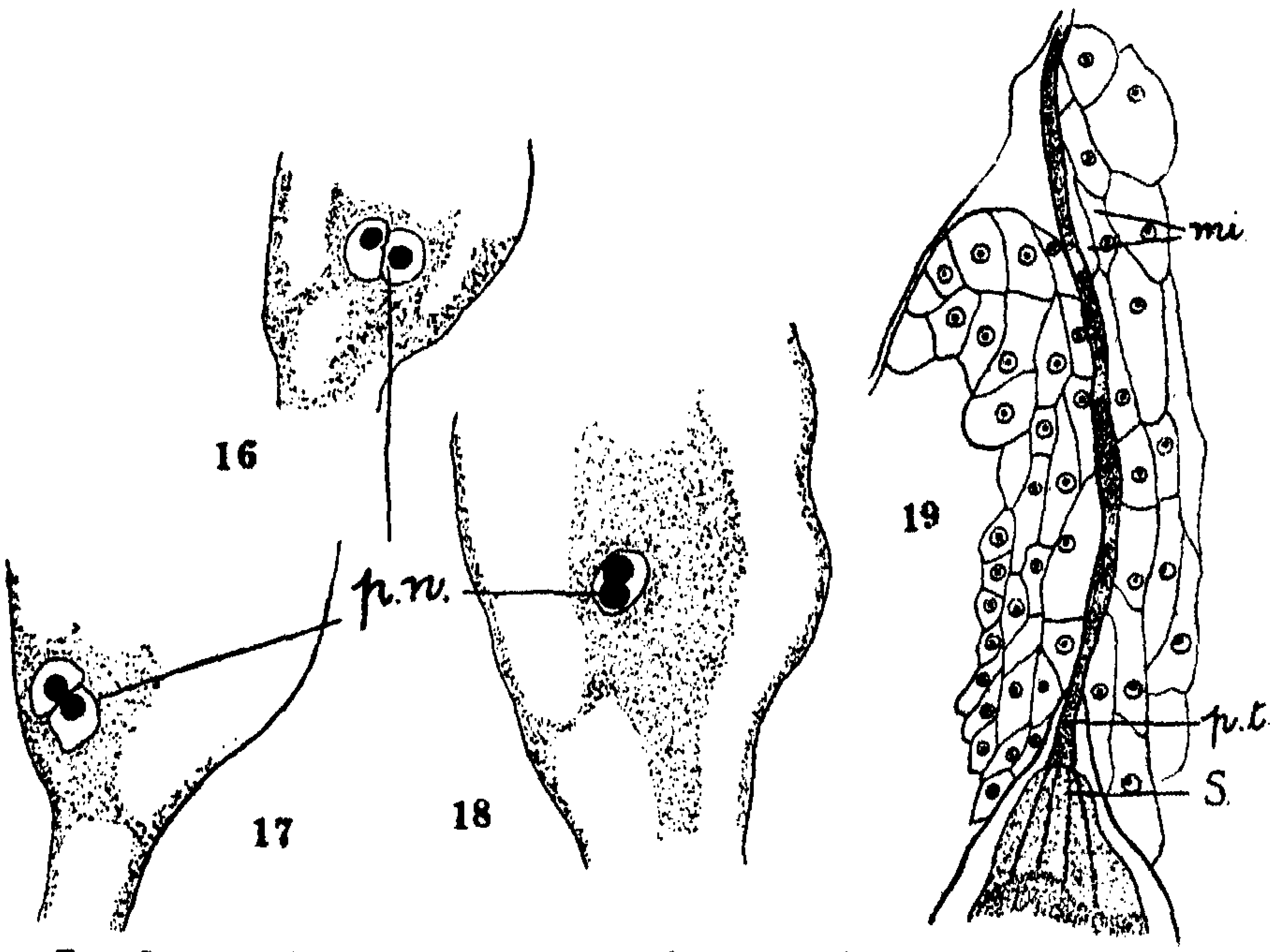
Text-fig. 10.—A median longitudinal section through a young ovule. The massive integument (int.), partially enclosing the nucellus (nuc.), is seen. The large cell terminating the axial row of the nucellus is the megaspore mother-cell (meg.m.c.). The nucleus is in synapsis; (mi.) micropyle. (x 600).

functions in the production of the female gametophyte. Even in this genus, *Trapella*, the cell adjacent to the distal one may on occasion be the one to function.

In the Monocotyledons and the Archichlamydeae the functioning of the micropylar megaspore has only been found in a few cases. Thus Treub and Mellink (1880) have observed that the outer of the two megaspores normally produces the embryo-sac in *Agraphis*, but that the inner of the two megaspores develops to the four-nucleate stage. Again Campbell (1900) reports that the outer micropylar megaspore in *Dieffenbachia* is the one to produce the female gametophyte. Turning to the Archichlamydeae it is found that *Loranthus*, as described by Treub (1882), is the only case in which the micropylar megaspore is the functional one.

A survey of these facts is sufficient to emphasise the rarity of the phenomenon described above for *Styphelia longifolia*.

Contrary to expectation, the three remaining megaspores do not disintegrate, but continue to increase in size, each being limited by a thin membraneous wall. The nucleus is large and contains a single nucleolus. The cytoplasm is distinctly vacuolate and takes the form of thick strands (Text-figs. 13 and 14). The nucleus of the micropylar megaspore divides, and the typical eight-nucleate stage of the Angiosperm female gametophyte is evolved. In Text-fig. 12 the two elongated cells S_1, S_2, adjoining the micropyle are obviously the young

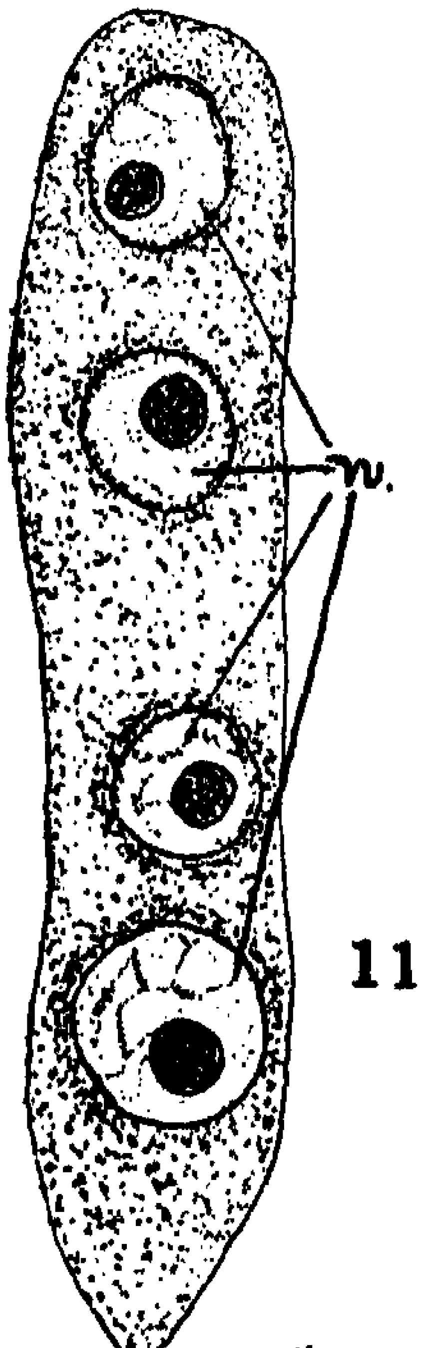


Text-figs. 16, 17, and 18 show the polar nuclei (p.n.) in various stages of fusion. Fusion occurs in the region where the embryo-sac begins to narrow. (x 270).

Text-fig. 19.—A median longitudinal section through an ovule showing the passage of the pollen tube (p.t.) through the micropyle (mi.) and into the embryo-sac. The lower end of the tube is seen at the apex of one of the synergids (S_1). (x 200).

synergids. The other six nuclei vary somewhat in size. At this stage it is to be noted that the eight cells of the gametophyte occupy the upper region of the sac (Text-figs. 12 and 15). Nevertheless, their positions, relative to one another in the sac, are quite normal, and in no way suggestive of the extreme lack of polarity characteristic of *Peperomia pellucida*, as described by Campbell (1899) and Johnstone (1900) respectively.

As the embryo-sac grows, however, four nuclei are aggregated at the micropylar end, while the other four are located towards the chalazal end of the sac. These latter nuclei, however, *do not* always congregate at the extremity, as is usual in Angiosperms. The distribution of the nuclei after separation is shown in Text-fig. 10 of my preliminary note (1923). The polarity characteristic of the



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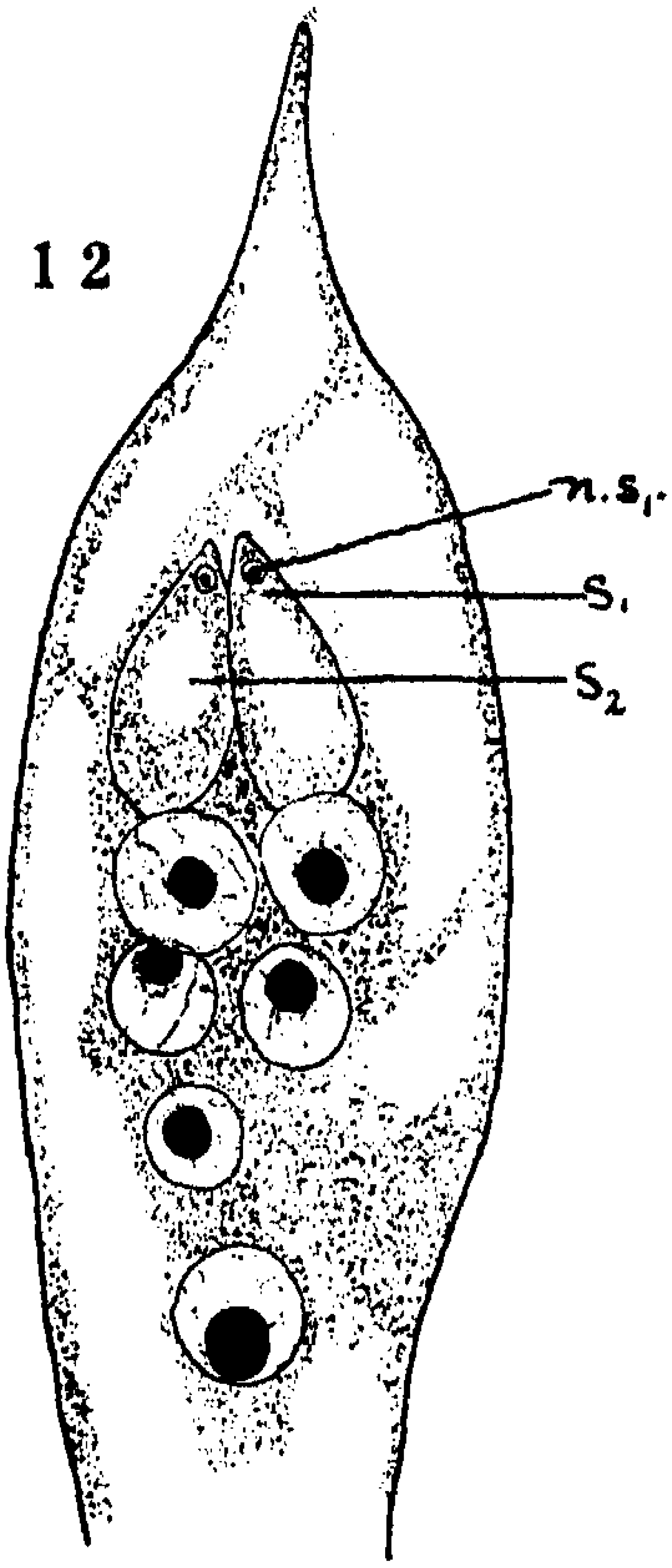

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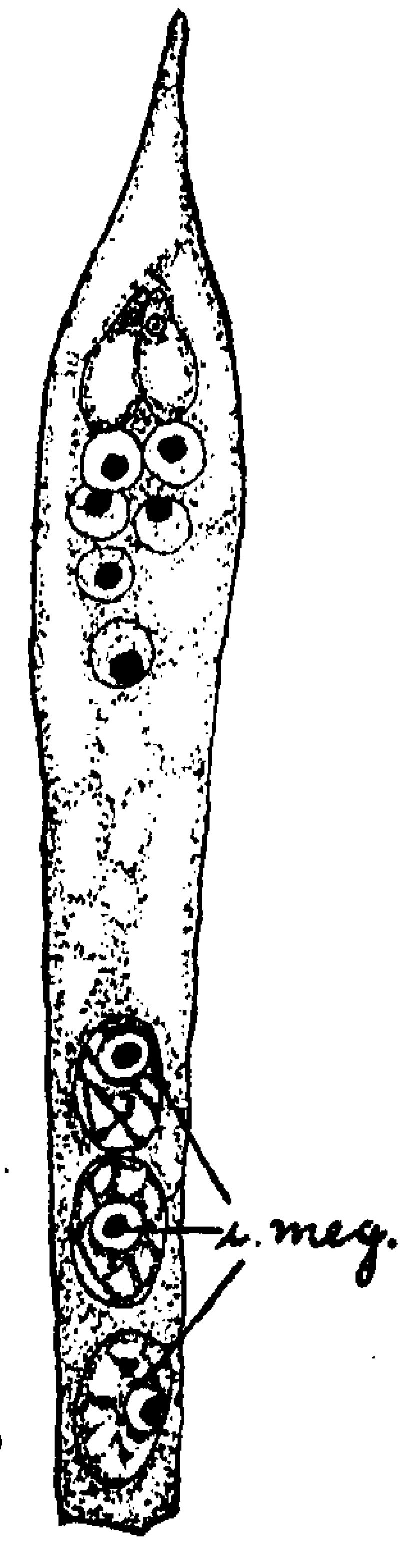

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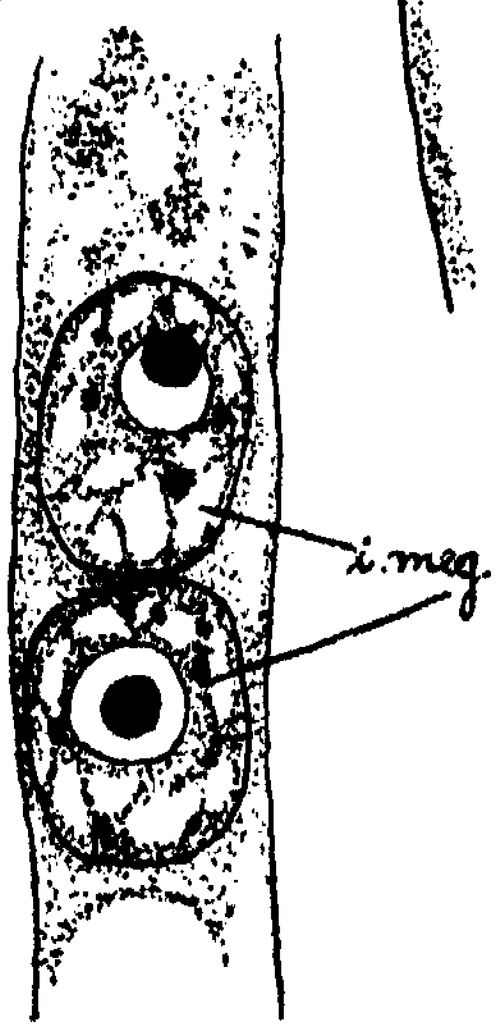

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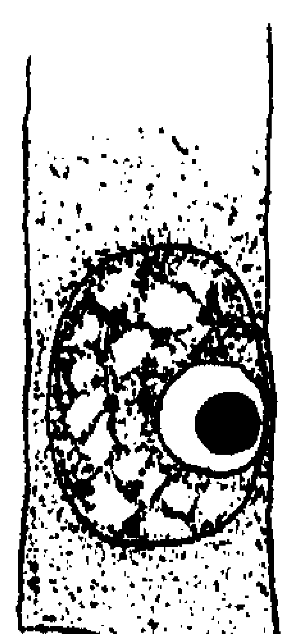

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Text-fig. 11 shows the 4-nucleate condition consequent on division of the spore mother cell. Each nucleus (n.) is the nucleus of a young megaspore. (x 920).

Text-fig. 12.—A median longitudinal section of the embryo-sac. The eight nuclei of the female gametophyte are shown, the two large pyriform cells are the synergids (S_1, S_2); (n. S_1) nucleus of synergid. (x 400).

Text-fig. 13.—Two of the non-functional megaspores (i.meg.) as seen in the microtome section immediately following, that of Text-fig. 12. The large nucleus, cytoplasmic strands, and wall of megaspore are clearly seen. (x 400).

cells of the Angiosperm sac is thus attained somewhat late. Very soon a nucleus from either end separates from its associates, and passes towards the middle of the sac, where fusion occurs (Text-fig. 18).

Female Gametophyte.

Egg-Apparatus.

The outstanding feature of the female gametophyte is the egg apparatus in which the synergids are extraordinarily enlarged (Text-figs. 21 and 22). The synergids are precisely pyriform and at maturity the beak of each protrudes slightly into the micropyle. The narrow end has a distinctly striated appearance, and stains lightly with Haidenhain's iron-alum haematoxylin, and Fleming's triple stain (Text-fig. 21). This behaviour is in striking contrast to the deep staining characteristic of the body of the synergid. Each synergid has one or several vacuoles, and a large nucleus (Text-fig. 22). The egg is the lowermost cell of the egg apparatus, and its lower extremity, in which the nucleus is situated, extends below the synergids.

Polar Nuclei.

The polar nuclei are large, and distinct. Their gradual approach and subsequent fusion are demonstrated in Text-figs. 16, 17 and 18. This fusion occurs prior to fertilization. At this stage the embryo-sac is somewhat club-shaped, with the head, which contains the egg-apparatus, adjacent to the micropyle. The polar nuclei fuse in the region where the sac is beginning to narrow (Text-fig. 16).

Antipodal cells.

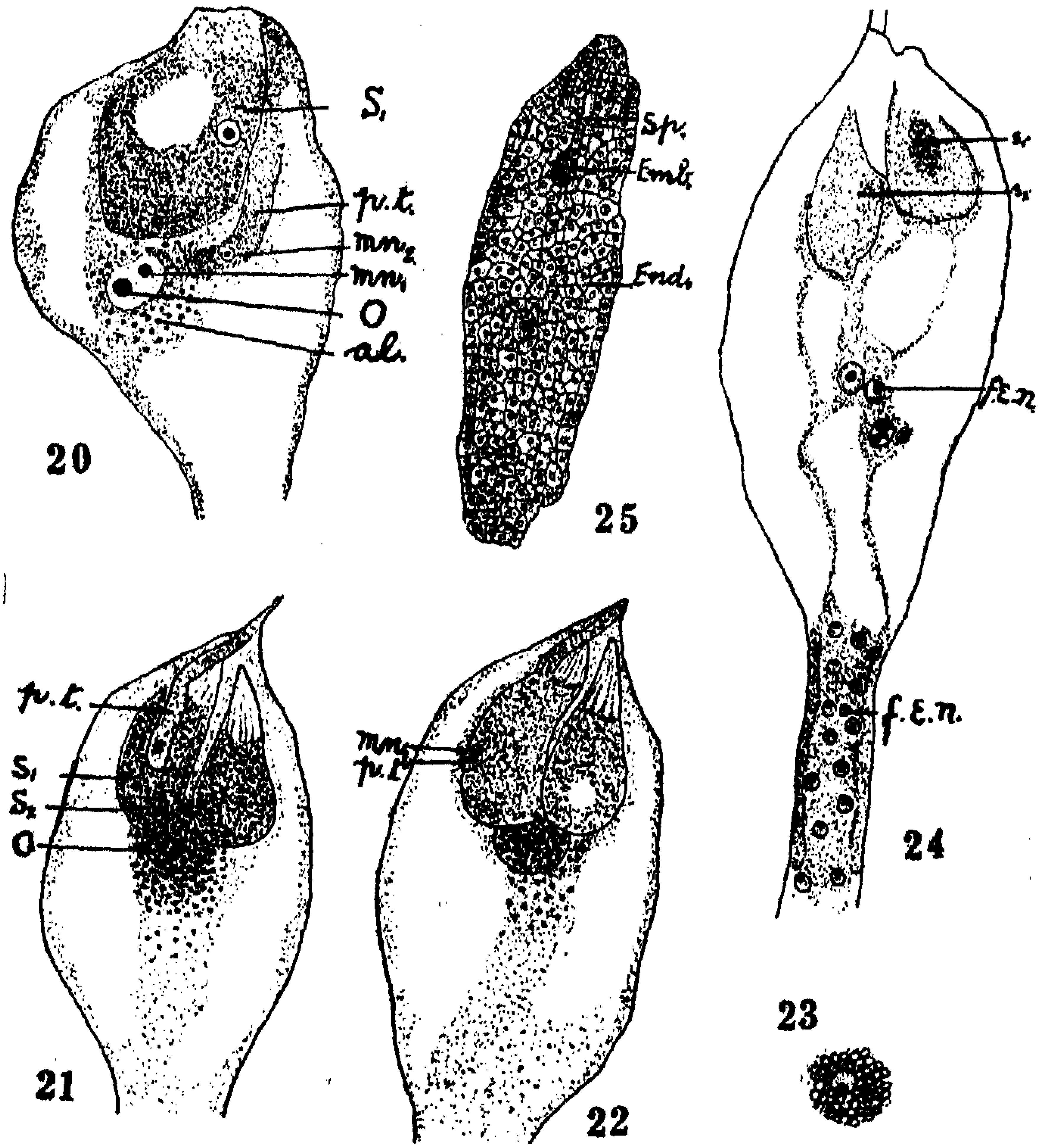
The most outstanding feature of the antipodal cells is the insignificant part they play in the life-history of the gametophyte. They disintegrate before fertilization and only occasional traces of them can be found by the time the polar nuclei have fused. Dense staining of the contents in the lower portion of the sac no doubt indicates the locus of their disintegration. Thus it is evident that the antipodals represent the most insignificant feature of the female gametophyte, and play no part in the nutrition of the sac.

Fertilization.

When the flower opens the microspores are in the binucleate condition (Text-fig. 8). Pollination occurs soon after the exposure of the stigma, as the pollen tube is found traversing the micropyle in the material fixed within a few days of the expanding of the petals (Text-fig. 19). The micropyle is narrow, and so the pollen tube remains thin until entrance to the sac has been effected. In many cases the synergids protrude slightly into the micropyle before the pollen tube actually reaches the vicinity of the sac. Access to the egg apparatus is thus facilitated. At this stage of development starch grains begin to appear in the cytoplasm in the region of the egg and fusion nucleus respectively, and by the time the pollen tube reaches the egg apparatus a dense aggregation of grains is seen, especially around the egg. This is illustrated in Text-figs. 20-23. In some cases the grains are packed so closely that the egg is more or less hidden.

Text-fig. 14.—The third non-functional megaspore as seen in the microtome section succeeding that of Text-fig. 13.

Text-fig. 15.—Composite drawing composed from the three sections of Text-figs. 12, 13, and 14. The cells of the female gametophyte and the three non-functional megaspores (i.meg.) are seen to be enclosed in a common chamber. (x 400).



Text-fig. 20.—Another view of the micropylar region of the sac. A pollen tube (pt.) is seen alongside one of the synergids (S_1). Near the extremity of the tube a male nucleus (mn_2) is depicted, while in front a structure strongly suggestive of a second male nucleus (mn_1) fusing with the nucleus of the egg (o.) is apparent. Numerous starch grains (al.) are seen in the cytoplasm around the egg nucleus. (x 270).

Text-fig. 21.—Another view of the pollen tube (p.t.) within the sac. In this case the tube seems to have penetrated, and to be making its way through one of the synergids (S_1). Here again, the starch grains are aggregated around the egg (o.). (x 270).

Text-fig. 22.—This section immediately succeeds, in the microtome series, the one shown in Text-fig. 21. The lower extremity of the tube (p.t.) which contains the male nucleus (mn_1) is seen emerging from synergid S_1. (x 270).

Text-fig. 23.—The close packing of the starch grains around the egg nucleus is illustrated. (x 270).

Text-fig. 24.—A longitudinal section through an embryo-sac after fertilisation. The two synergids, S_1, S_2, are still visible, although somewhat distorted. A few

The pollen tube was often seen in the narrow passage of the micropyle (Text-fig. 19). The large synergids, however, with their rapid absorption and tenacious retention of stain, tend to conceal the course of the pollen tube within the sac. Consequently the tracing of its progress towards the egg is a matter of unusual difficulty. However, by the careful destaining of overstained sections, demonstration of the course of the pollen tube within the sac was effected in several cases. Text-fig. 20 shows a typical example. There the pollen tube is seen alongside one of the synergids, and its extremity is turned towards the egg. One nucleus—the male—is seen near the end of the tube, while the appearance of the structure adjoining strongly suggests the fusion of the egg nucleus with the other male nucleus. Again, in Text-fig. 21, the pollen tube is seen emerging from the micropyle and making its way down between the wall of the sac and a synergid. It evidently pierces the synergid, because the next section of the series, Text-fig. 22, shows the extremity of the same pollen tube emerging from the same synergid. A male nucleus is seen in each portion of the pollen tube. Division of the zygote does not at once follow fertilization.

The endosperm nucleus, on the other hand, shows immediate activity, and very soon free nuclei are seen scattered throughout the sac (Text-fig. 24). It is distinctly noticeable that relatively few though large nuclei are formed within the enlarged micropylar region, while on the other hand very numerous nuclei are formed within the lower and narrower region.

Growth of the sac proceeds apace, and its form undergoes a complete transformation. This is due to the fact that the middle region of the sac enlarges enormously, while the micropylar end shows no very appreciable increase in size. The endosperm nuclei continue to divide, wall formation supervenes, and finally a massive endosperm is developed, as indicated in Text-figs. 25 and 28-30 (also 1923, Text-figs. 11 and 12).

It will be noted that in the mature seed the endosperm does not extend quite to the chalazal extremity of the sac. This leaves a small chalazal chamber between the endosperm proper and the three non-functional megaspores.

The Embryo.

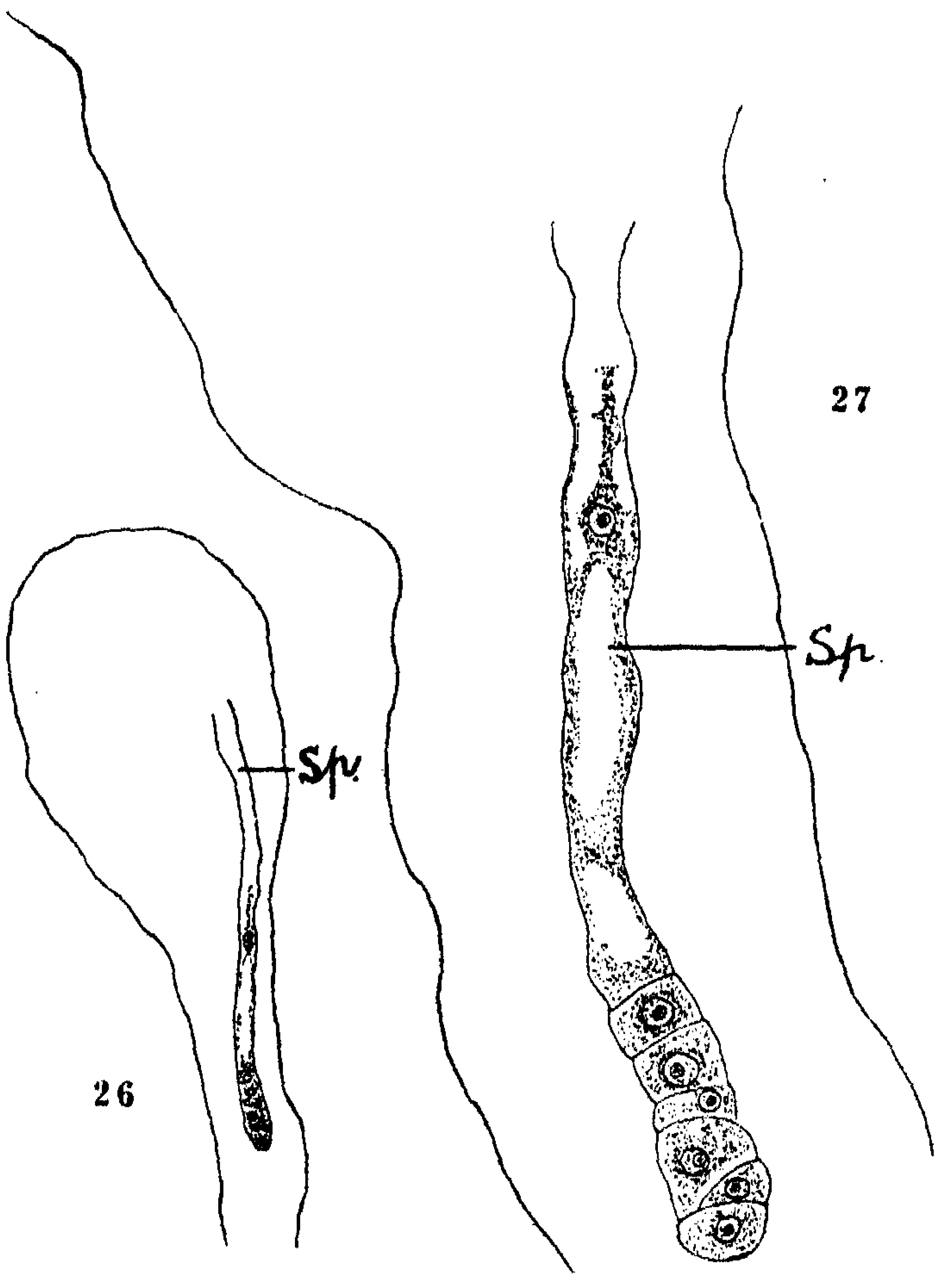
The actual division of the zygote has not been demonstrated, but a very young embryo is delineated in Text-fig. 26. At this stage all traces of the starch grains, formerly so abundant, have disappeared (Text-fig. 24). The proembryo is provided with an extremely long suspensor, the evident function of which is to transfer the embryo from the micropylar chamber, and push it deep down into the region where endosperm formation is going on.

A slightly older embryo amid the endosperm is shown in Text-fig. 28. The embryo continues to develop, and assumes the rounded form indicated in Text-figs. 29-31. The digestive action of the embryo is indicated by the corroded appearance of the adjacent endosperm cells. This feature is also apparent at the earlier stage of development indicated in Text-fig. 28. Cell division continues until the stage shown in Text-fig. 31 is reached. The dermatogen is well defined, and the differentiation into periblem and plerome is suggested. The development of the embryo has not yet been followed beyond this stage.

large free endosperm nuclei (f.e.n.) are seen in the upper sac, while in the lower and narrower region, abundant cytoplasm with numerous free endosperm nuclei (f.e.n.) is found. (x 270).

Text-fig. 25.—A longitudinal section through the endosperm (end.). An embryo (emb.) and suspensor (sp.) are seen embedded in the endosperm tissue. (x 150).

At this point the writer would again call attention to the shape of the mature embryo sac (1923, Text-fig. 11). At one end a large micropylar cavity is developed in a manner similar to that so often figured by M. Peltrisot (1904) in his extensive investigations in the Ericaceae. This cavity is separated by a constriction from the distended region below, which forms the main body of the



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Text-fig. 26.—This view shows a very young embryo with the extremely long suspensor (sp.) pushing the embryo into the lower region of the sac where endosperm formation is going on. (x 180).

Text-fig. 27.—Another view of the same highly magnified. (x 600).

sac. The function of this chamber is not apparent, because, as already pointed out, it contains at maturity only a few free endosperm nuclei.

It may, however, have a haustorial function, as in the Ericaceae (Peltrisot, 1904). The embryo develops amid the endosperm in the central region of the sac, but the greatly elongated suspensor traverses the micropylar chamber, and

passes through the constriction separating these two regions (Text-figs. 26 and 27).

The persistent megaspores remain in full activity until long after fertilization, for they are seen to be intact when the embryo is at the stage indicated in Text-fig. 28. Their disintegration commences when the endosperm approaches maturity, for at the stage indicated in Text-fig. 31 only the positions previously occupied by them are apparent. Accordingly it is evident, that the megaspores retain their vitality until nutrition for endosperm formation has been supplied. This is what might be expected, seeing that the food supply of the embryo is now assured by the presence of a copious endosperm.

The various phases of the life-history of *Styphelia longifolia* having been presented, it remains to probe into the significance of the several peculiar features which stand revealed.

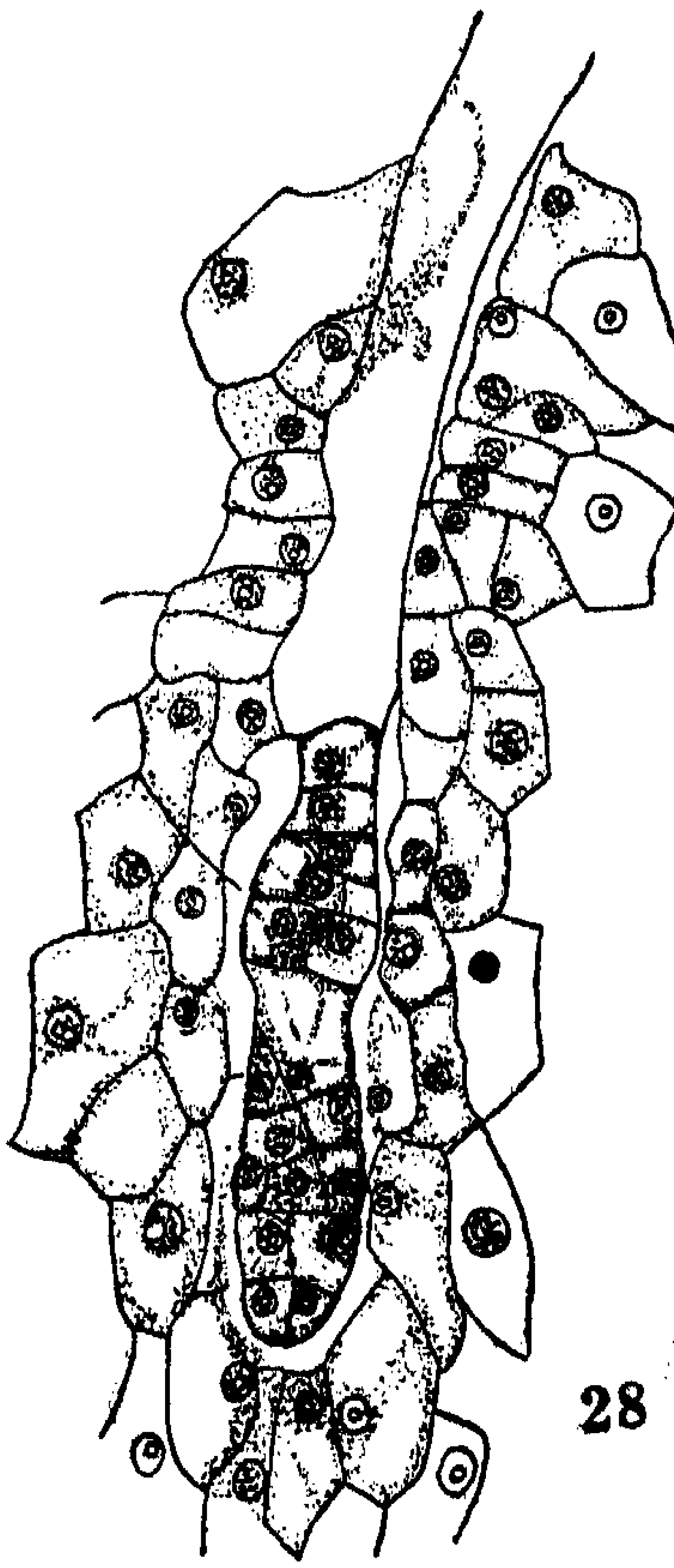
The functioning of the micropylar megaspore has already been discussed, but the phenomenon of far more fundamental importance—and one which the writer believes has never previously been demonstrated—is the long-continued active persistence of the three inner megaspores. It must be borne in mind, of course, that Oliver (1888), in the case of *Trapella*, describes an example in which megaspore persistence is demonstrated, but at the same time it will be realised that in *Trapella* only one of the non-functional megaspores—the innermost—persists for any length of time, and in this particular case it develops into a bi-cellular haustorium. Moreover, the megaspores in *Trapella* are partitioned off from each other and from the embryo-sac by definite cell walls.

Now the Epacridaceae are generally conceded to be fairly primitive representatives of the Sympetalae, which in turn are derivatives from the Archichlamydeae. The persistence of the megaspores in *Styphelia* immediately suggests that this phenomenon represents the survival of a primitive condition when all of the four megaspores were functional. But, if this interpretation be correct, then why has a similar state of things never been reported in the more primitive and presumably ancestral forms in the Archichlamydeae?

A possible reply to this is that the Epacridaceae—which are confined to the Southern Hemisphere in general, and to Australia in particular—may represent a type which has emerged and diverged in very early times from extremely primitive Angiosperms, and has ever since preserved its identity and, in a special degree, one of its ancestral features.

Another aspect of this discussion relates to the present day function of the three megaspores in question. They are highly nourished, vigorous organs up to the time of endosperm formation, and it has occurred to the writer that they may be instrumental in the nourishing of the embryo-sac. The innermost megaspore is in close juxtaposition to the conducting tissue of the chalaza, and any nutritive supplies therefrom would clearly meet with little resistance in passing upwards by way of the megaspores to the developing functioning megaspore, female gametophyte and endosperm, especially when it is remembered that the megaspores are not separated from each other by walls. Furthermore, in the case of *Styphelia*, the common chamber enclosing the female gametophyte and the three megaspores clearly provides an increased surface for the absorption of nutritive supplies from the surrounding tissue. It is suggested then that the megaspores have assumed a haustorial function, and form a *via media* for the transfer of nutritive supplies from the conducting tissue of the chalaza to the embryo-sac.

Finally, it has been pointed out by Coulter and Chamberlain (1915) that



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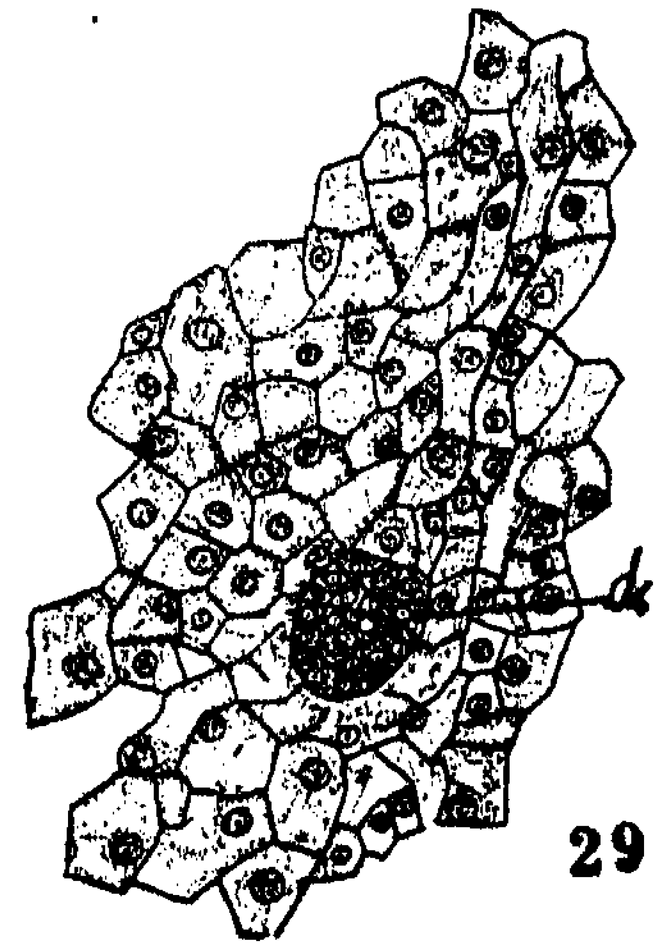

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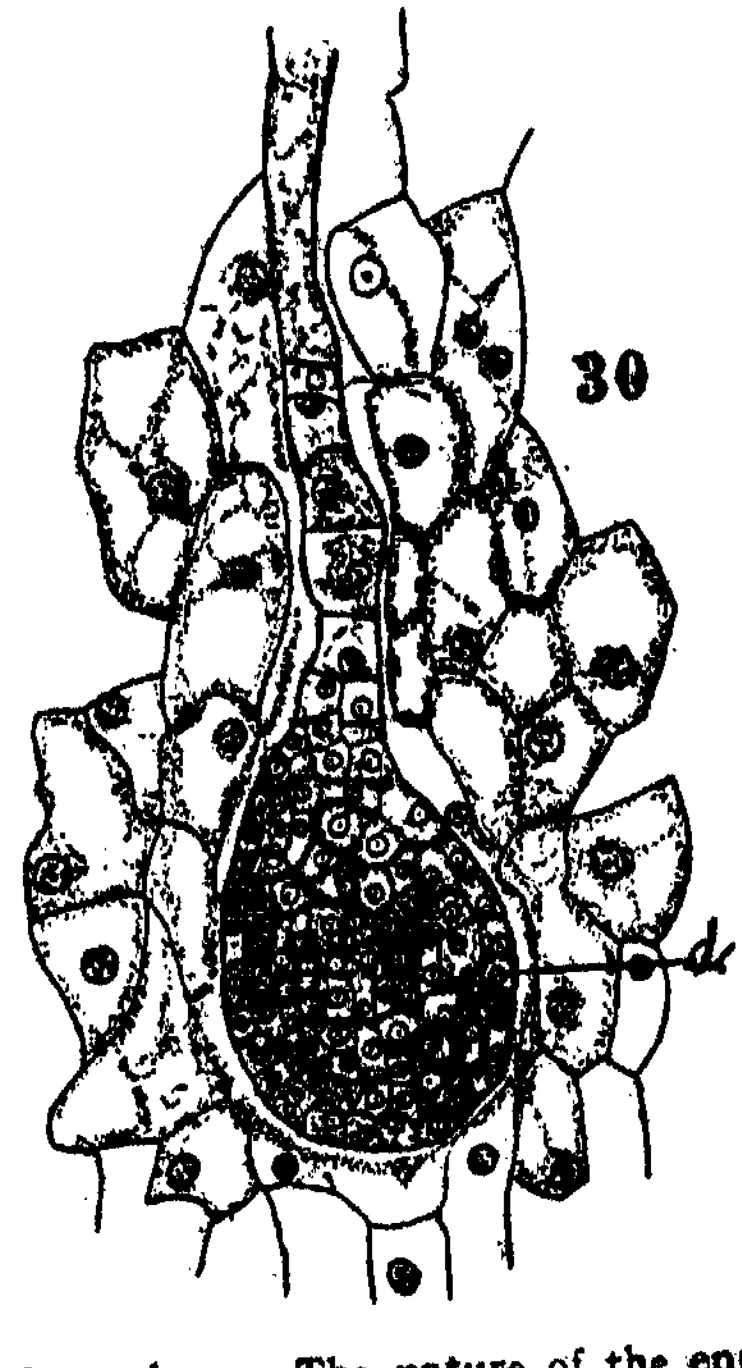

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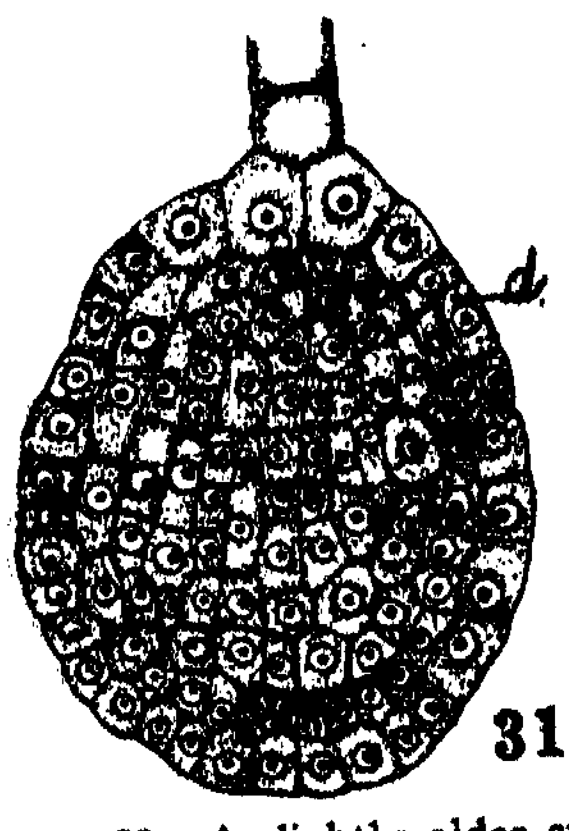

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Text-fig. 28.—A slightly older stage of the embryo. The nature of the encasing endosperm cells is illustrated and the digestive action of the embryo is apparent. Also Text-figs. 29-31. (x 270).

Text-fig. 29.—A further stage in the development of the embryo is illustrated here. Periclinal walls have initiated the dermatogen (d.). (x 270).

Text-fig. 30.—A still older stage of the embryo. Differentiation of the derma-

the known cases of the functioning of the micropylar megaspore are so few that the phenomenon may indicate some peculiar condition, and it has occurred to the writer that this peculiarity is bound up, in some cases at least, with the haustorial activity of the non-functioning megaspores. Certainly this is so in the case of *Styphelia longifolia* and *Trapellà sinensis*. In any case it is evident that if the non-functional megaspores are to be instrumental in the nutrition of the embryo-sac, then their most advantageous position is adjacent to the chalaza, and, that being so, the selection of the micropylar megaspore as the future embryo sac is accounted for.

Summary.

The anther consists of two microsporangia instead of the four usual in Angiosperms. No fibrous layer is formed by the sub-epidermal cells of the wall of the microsporangium. The epidermis assumes the role of the usual fibrous layer, and by differential thickening and variation in shape of the constituent cells effects and controls the specialised method of longitudinal dehiscence. In the younger stages the thick stratified walls of the microspore provide a reserve food supply for the further development of the microspores which are shed in the bi-nucleate condition.

A single anatropous ovule is contained in each of the five loculi of the gynoecium. The nucellus consists of a single axial row of cells, surrounded by an epidermal layer one cell thick, enclosed by a single massive integument. The distal cell of the axial row functions as the megaspore mother cell. No parietal cell formation occurs.

The spore mother cell undergoes reduction division, and produces a row of four megaspores which are not separated by cell walls. The micropylar megaspore functions and produces the normal eight-celled gametophyte, a somewhat rare occurrence in Angiosperm life-history.

The female gametophyte is characterised by the extraordinarily large pyriform synergids, each with a pronounced striated apical region. The polar nuclei fuse prior to fertilization. The antipodal cells are insignificant and evanescent. The polarity of the cells characteristic of the Angiosperm gametophyte is assumed somewhat late.

The three innermost megaspores do not disintegrate but enlarge very considerably, and persist in an active state until endosperm formation is almost completed. This long-continued persistence and activity of the three non-functional megaspores has not previously been recorded in the life-history of the Angiosperm.

The pollen tube makes its way down through the micropyle, enters the embryo-sac, sometimes piercing a synergid *en route* to the egg, and brings about fertilization in the normal manner.

Immediately after fertilization the endosperm nucleus divides rapidly, producing numerous free nuclei, but wall formation speedily supervenes, and a copious endosperm is developed. A micropylar chamber, similar to that described by M. Peltrisot in his researches on the Ericaceae, is formed at the apical region of the sac. A chalazal chamber is also present in the mature seed.

The embryo is transferred from the micropylar chamber into the central

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togen (d.) is complete except in the region where the radicle is to appear. (x 270).

Text-fig. 31.—This section represents the final stage found in this investigation. The dermatogen (d.) is very evident, while the regions of the periblem and the plerome respectively are suggested. (x 270).

region of the endosperm by a very long narrow suspensor. Various stages in the development of the embryo are delineated, but no abnormal features have been recorded.

It is suggested that the persistence of the three non-functional megaspores represents the retention of an ancestral condition of the Angiosperm, and that in consequence the Epacridaceae have diverged in early times from very primitive types, and have since preserved their identity in an extraordinary degree. The restricted distribution of the family supports this view. The writer is of the opinion that the present day function of these persistent megaspores is purely haustorial.

For helpful advice and kindly criticism given during the course of this research, I desire to place on record my sincere thanks to Professor Lawson, in whose laboratory these investigations were carried out. My thanks are also due to Dr. McLuckie for similar good offices.

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RESULTS FROM ROY BELL'S MOLLUSCAN COLLECTIONS.

By Tom Iredale.

(Plates xxxiii.-xxxvi.)

[Read 25th June, 1924.]

Roy Bell has made several collections of molluscs which I hope to report upon more fully in the near future, especially in connection with zoogeographical problems relating to Australasia. Roy Bell was born on Raoul Island, in the Kermadec Group, and was of the greatest assistance to all the members of the Expedition of 1908, but more especially to myself, as I found he had an excellent knowledge of the larger shells and was keenly interested in this group. After I left the island, he made still larger collections, which were partly reported upon by Mr. W. R. B. Oliver, now at the Dominion Museum, Wellington, one of our party. Owing to an unexpected disaster which compelled all the settlers (the Bell family) to leave the island, I was able to obtain his services for Mr. G. M. Mathews, to investigate the bird life of Norfolk and Lord Howe Islands. While upon these islands he made large collections of molluscs for me, until the Great War suspended all scientific work and publication. Bell volunteered, though not sound, and served four years, and upon his demobilisation made more collections in Australia. He landed at Melbourne and went to Port Fairy, Victoria, where he studied the Adelaidean fauna; he then travelled to Mallacoota, Victoria, where he found almost a pure Peronian Mollusc Fauna. This was all I had desired for comparison, but the influenza outbreak prohibiting his return to New Zealand, he travelled to Eden in Twofold Bay and stopped there until the epidemic was over. He employed himself in making a thorough survey of the molluscan fauna, shore collecting in every available place, dredging throughout the Bay in from five to twenty-five fathoms, and outside, as far north as Merimbula, in water to the same depth, and in deeper water, from fifty to seventy fathoms, off Green Cape. In this essay I deal with the Twofold Bay collections, but use the other material for comparison. As all the material has been collected by one man, employing the same methods, the results are especially valuable in this respect, the personal equation, no small factor, being eliminated. Angas recorded shells, received from Brazier, from Twofold Bay, while apparently Cox and Hedley also collected there, but I have seen no note of Disaster Bay, the southernmost limit of New South Wales, which Bell visited. The littoral fauna was found to be stationary, little trace being found at a depth of only five fathoms, while from five to twenty fathoms, the molluscan life was uniform; but beyond twenty fathoms a new fauna was developing, and from the deeper water, 50-70 fathoms, still more different forms were secured, but, as usual, much of the deeper water material was dead. Again, the shells washed up on the beach vary according to the seasons, many being found during winter

gales which are not met with in summer; and these also are rarely dredged. Thus, to investigate completely a faunal area, the seasons must be also considered as well as much dredging and shore collecting. Probably a year's collecting by a company of workers would show three-quarters of the fauna in a restricted area.

Hedley proposed a subdivision of the Australian coastline, as regards the marine fauna, into four regions; these have been generally accepted by scientific investigators, but seem to have been misunderstood by some who were ignorant of the facts. The present collections were made for the purpose of enlarging our knowledge of the regions, especially by means of the Loricate fauna, as I had found these indicated the general results very fairly. I had made collections at Port Curtis and at Caloundra, Queensland, and have recently collected continuously on the Sydney beaches, while I have paid a visit to Port Fairy, Victoria.

Hedley's Regions are as follows: the Solanderian covered the coastline of Eastern Australia from Cape York to Moreton Bay; the Dampierian Region ran westward from Cape York to Shark's Bay, Western Australia; the Adelaidean Region extended along the south and south-west coasts of Australia from Wilson's Promontory, in Victoria, to Shark's Bay, and included the north and west coasts of Tasmania; the Peronian Region took in the rest of the east coast of Australia and Tasmania, and the east coast of Victoria. The only emendations yet proposed have been the separation of the eastern coast of Tasmania under the name Maugean, and the acceptance of the Solanderian as inclusive of the Dampierian. I have continually compared Peronian shells with the (same) species from southern Tasmania, and commonly find them to differ to a greater or less degree. At the point of inosculation of Regions, species of the two Regions will commonly be met with, but the further away from this point the purer the collection. Thus, to emphasise this point, Sydney should show almost a pure Peronian fauna, while Adelaide would show just as pure an Adelaidean fauna, but collections made at Twofold Bay or Western Port might show an appreciable Adelaidean or Peronian element respectively. At Twofold Bay no Solanderian forms would be expected, and these hypotheses have been absolutely confirmed by facts. We can now with certitude generally designate the littoral marine mollusca with their Regional names. It must be remembered that we are dealing with the littoral fauna, and that the deepwater fauna does not obey these laws so exactly, but curiously enough, even this fauna shows distinction in the same manner. With regard to the exact relationship of these deepwater forms and also the fossils, I have published a note (Proc. Malac. Soc., xv., 1922, pp. 37-8) indicating a solution of the nomination of these related forms. A paper by Chapman and Gabriel (Proc. Roy. Soc. Vict., xxxvi., n.s., 1923) has just been received, in which they record their belief that the recent and fossil forms must be compared and contrasted, and then describe some new species, and record other fossils under living names. They do not appear to have considered my note as simplifying their troubles. They have described a new species *Cellana cudmorei* as differing from *C. variegata* in a few details. *C. variegata* is the common Sydney limpet, which varies according to station and locality, and their species could be matched in any series procured at any place. I regard their form with exactly the same views as they have expressed, but my method of nomination obviates any criticism. I will give details of my scheme under the first species that leads itself to such treatment, rather than in this introduction. These notes are critical of the nomination and status of New South Wales marine molluscs, and are revisional of the names utilised by Hedley in his Check List

published in 1918. The whole of this work is based upon Hedley's foundation, and should be regarded as ornamental rather than as destructive. In the same way as the stonemason improves the face of the laid stone, I have amended Hedley's List: the stone itself is not altered, only beautified, and without the stone to work upon the stonemason could not work. I have made much use of Pritchard and Gatliff's Victorian List, with its continuation by Gatliff and Gabriel, Tate and May's List of Tasmanian molluscs with May's additions, and more recently May's Check List and Illustrated Index of Tasmanian shells, and Sir Joseph Verco's numerous and invaluable papers on South Australian Mollusca. As all these essays have appeared in circumscribed and well known Australian scientific journals, I am not giving complete references save in necessary cases. This will save very much space and will not cause much inconvenience to the interested worker. It should be stated here that the collection reported upon was studied at the British Museum (Natural History) in conjunction with the use of Sherborn's MSS., and has been reviewed by means of the collection in the Australian Museum, so that both sides of each matter at variance have been viewed. The collection will be placed in the Australian Museum for future reference, and it should be emphasised that the thanks of the scientific world are due to Mr. Charles Hedley, who has assisted me in every possible way in this revision of his own life-work. We are agreed that it will be many years before such drastic treatment can be again served out to the marine molluscs of this State.

To save space the following notes have been condensed to a minimum, only the bare facts being recorded, so that it may not be realised that many of these notes represent months of research and have not been hastily produced. Twice as many notes have been withheld for further consideration in connection with fieldwork, and the multitude of new generic names here introduced is through comparison, with the assistance of the leading British malacologists, of these Austral forms with the Palaearctic types.

I have proposed as new:—

Nucula praetenta, nom. nov., for *Nucula umbonata* Smith.
Nuculana (dohrnii) tragulata nov.
Comitileda, gen. nov., for *Leda miliacea* Hedley.
Poroleda pertubata, nom. nov., for *Poroleda lanceolata* Hedley.
Propeleda, gen. nov., for *Leda ensicula* Angas.
Glycymeris striatularis suspectus, subsp. nov.
Neotrigonia gemma, sp. nov.
Notolimea, gen. nov., for *Lima australis* Smith.
Lima nimbifer, sp. nov.
Trichomusculus, gen. nov., for *Lithodomus barbatus* Reeve.
Fluviolanatus, gen. nov., for *Modiolarca subtorta* Dunker.
Modiolus deliniflcus, nom. nov., for *M. albicostus* auct.
Amygdalum beddomei, nom. nov., for *Modiolus arborescens* auct.
Solamen rex, gen. et sp. nov.
Eximiothracia, gen. nov., for *Thracia speciosa* Angas.
Thraciopsis peroniana, nom. nov., for *T. elegantula* auct.
Thracidora, gen. nov., for *Thraciopsis arenosa* Hedley.
Myadora royana, sp. nov.
Myadora complexa, sp. nov.
Eucrassatella, gen. nov., for *Crassatella kingicola* Lamarck.
Talabrica, gen. nov., for *Crassatella aurora* A. Adams and Angas.

Salaputium, gen. nov., for *Crassatella fulvida* Angas.
Bathycardita, gen. nov., for *Cardita raouli* Angas.
Mendicula memorata, gen. and nom. nov., for *Lucina induta* Hedley.
Notomyrtea, gen. nov., for *Myrtaea botanica* Hedley.
Numella, gen. nov., for *Diplodonta adamsi* Angas.
Melliteryx, gen. nov., for *Erycina acupuncta* Hedley.
Borniola, gen. nov., for *Bornia lepida* Hedley.
Pratulum, gen. nov., for *Cardium thetidis* Hedley.
Gouldiopa, gen. nov., for *Gouldia australis* Angas.
Fluctiger royanus, gen. et sp. nov.
Notocallista, gen. nov., for *Cytherea kingii* Gray.
Chioneryx, gen. nov., for *Venus striatissima* Sowerby.
Eumarcia, gen. nov., for *Venus fumigata* Sowerby.
Tellina beryllina, nom. nov., for *Tellina inaequivalvis* Sowerby.
Semelangulus, gen. nov., for *Tellina tenuilirata* Sowerby.
Abranda, gen. nov., for *A. rex*, nom. nov., for *Tellina elliptica* Sow.
Solen correctus, nom. nov., for *Solen sloanii* auct.
Scissurona, gen. nov., for *Scissurella rosea* Hedley.
Scissurona rosea remota, subsp. nov.
Subzeidora, gen. nov., for *Emarginula connectens* Thiele.
Rimulanax, gen. nov., for *Puncturella corolla* Verco.
Cosmetalepas, gen. nov., for *Fissurella concatenata* Crosse and Fischer.
Sophismalepas, gen. nov., for *Fissurella nigrita* Sowerby.
Elegidion audax, gen. et sp. nov.
Rixa, gen. nov., for *Glyphis watsoni* Brazier.
Vacerra, gen. nov., for *Puncturella demissa* Hedley.
Vacerra demissa menda, subsp. nov.
Haliotis naevosum improbulum, subsp. nov.
Mesoclanculus, gen. nov., for *Trochus plebejus* Philippi.
Notogibbula, gen. nov., for *Gibbula coxi* Angas = *Stomatella bicarinata* A. Adams.
Minopa, gen. nov., for *Fossarina legrandi* Petterd.
Leiopyrga octona problematica, subsp. nov.
Spectamen, gen. nov., for *Trochus philippensis* Watson.
Ethminolia probabilis, gen. et sp. nov.
Minolia pulcherrima emendata, subsp. nov.
Salsipotens, gen. nov., for *Trochus armillatus* Wood.
Fautor, gen. nov., for *Zizyphinus comptus* A. Adams.
Astelena, gen. nov., for *Trochus scitulus* A. Adams.
Mimelenchus, subgen. nov., for *Phasianella ventricosa* Quoy and Gaimard.
Bellastraea, gen. nov., for *Astraea fimbriata* auct.
Bellastraea kesteveni, nom. nov., for *Astraea fimbriata* auct.
Stipator, gen. nov., for *Teinostoma starkeyae* Hedley.
Lodderena, gen. nov., for *Liotia minima* Ten.-Woods.
Patelloida alticostata antelia, subsp. nov.
Patelloida alticostata complanata, subsp. nov.
Notoacmea mixta mimula, subsp. nov.
Radiacmea insignis cavilla, subsp. nov.
Notoacmea flammea diminuta, subsp. nov.
Naccula, gen. nov., for *Nacella parva* Angas = *Patelloida punctata* Quoy and Gaimard.

Patellanax, gen. nov., for *Patella squamifera* Reeve.
Parvacmea illibrata mellila, subsp. nov.
Cellana variegata ariel, subsp. nov.
Botellus, gen. nov., for *Onoba bassiana* Hedley.
Coenaculum, gen. nov., for *Scala minutula* Tate and May.
Stiva royana, sp. nov.
Cacozelia, gen. nov., for *Cerithium lacertinum* Gould.
Seilarex, gen. nov., for *Seila attenuata* Hedley.
Gazameda, gen. nov., for *Turritella gunnii* Reeve.
Glyptozaria, gen. nov., for *Turritella opulenta* Hedley.
Colpospira guillaumei, sp. nov.
Crosseola, gen. nov., for *Crossea concinna* Angas.
Dolicrossea, gen. nov., for *Crossea labiata* Ten.-Woods.
Icuncula, gen. nov., for *Cingulina torcularis* Ten.-Woods.
Austrotriton (parkinsonius) basilicus, nov.
Cymatiella, gen. nov., for *Triton quoyi* Reeve.
Propesinum, gen. nov., for *Natica umbilicata* Quoy and Gaimard.
Propesinum umbilicatum minusculum, subsp. nov.
Propesinum (umbilicatum) mimicum, nov.
Triviella merces, sp. nov.
Baryspira fusiformis gaza, subsp. nov.
Scaphella caroli, nom. nov., for *Voluta maculata* Swainson.
Cymbiola complexa, nom. nov., for *Voluta punctata* Swainson.
Gemmoliva, subgen., nov. for *Oliva triticea* Duclos.
Cupidoliva, gen. nov., for *Olivella nympha* Adams and Angas.
Pervicacia, gen. nov., for *Terebra ustulata* Deshayes.
Pervicacia assecla, sp. nov.
Teleochilus royanus, sp. nov.
Colus novae-hollandiae grandiculus, subsp. nov.
Berylsma, gen. nov., for *Fusus waitei* Hedley.
Propefusus, gen. nov., for *Fusus pyrulatus* Reeve.
Microvoluta royana, sp. nov.
Peculator verconis, gen. et sp. nov.
Radulphus royanus, gen. et sp. nov.
Zella, gen. nov., for *Terebra beddomei* Petterd.
Galfridus, gen. nov., for *Triton speciosus* Angas.
Typhis philippensis interpres, subsp. nov.
Bedeva, gen. nov., for *Trophon hanleyi* Angas.
Pugillaria gen. nov., for *Siphonaria stowae* Verco.
Pugillaria stowae comita, subsp. nov.

Additions to the New South Wales fauna are: *Solemya australis* Lamarck, *Glycymeris holosericus* Reeve, *G. crebreliratus* Sowerby, *G. flabellatus* Ten.-Woods, *Ostrea mordax* Gould, *Chlamys undulatus* Sowerby, *Modiolus victoriae* Pritchard and Gatliff, *Gaimardia tasmanica* Beddome, *Myadora elongata* May, *M. subalbida* Gatliff and Gabriel, *Phragmorisma watsoni* Smith, *Lucina mayi* Gatliff and Gabriel, *Talabrica aurora* A. Ad. and Angas, *Dosinia victoriae* Gatliff and Gabriel, *D. caerulea* Reeve, *Solen vaginoides* Lamarck, *Saxicava subalata* Gatliff and Gabriel, *Ischnochiton tateanus* Bednall, *I. purus* Sykes, *Notoplax speciosa* H. Adams, *Scissurella ornata* May, *S. rosea* Hedley, *Macroschisma tasmaniae* Sowerby, *Leiopyrga octona* Tate, *Minopa legrandi* Petterd, *Calliostoma*

legrandi Ten.-Woods, *C. allporti* Ten.-Woods, *Phasianella rubens* Lamarck, *Radiacmea insignis* Menke, *Notoacmea flammea* Quoy and Gaimard, *Radiacmea calamus* Crosse and Fischer, *Patelloida submarmorata* Pilsbry, *Lironoba australis* Ten.-Woods, *Botellus bassianus* Hedley, *Rissoina lintea* Hedley and May, *Heterorissoa wilfridi* Gatliff and Gabriel, *Capulus australis* Lamarck, *Plesiotrochus monachus* Crosse and Fischer, *Colpospira quadrata* Donald, *C. runcinata* Watson, *Naricava vincentiana* Angas, *Phalium pyrum* Lam., *Natica shorehami* Pritchard and Gatliff, *Sinum zonale* Quoy and Gaimard, *Cymatiella quoyi* Reeve, *Baryspira tasmanica* Ten.-Woods, *B. fusiformis* Petterd, *Marginella tasmanica* Ten.-Woods, *M. dentiens* May, *M. gabrieli* May, *M. gatliffi* May, *M. caducocincta* May, *Terebra ustulata* Deshayes, *Propefusus pyrulatus* Reeve, *Nassarius tasmanicus* Ten.-Woods, *Philine columnaria* Hedley and May.

I have included some additions to the Victorian List of Peronian molluscs sent by Roy Bell from the Mallacoota district, such as *Ostrea glomerata* Gould, *Heterozona fruticosa* Gould, *Haploplax lentiginosa* Sowerby, *Haliotis coccoradiata* Reeve, *Clanculus floridus* Philippi, *Clanculus brunneus* A. Adams, *Cantharidella picturata* A. Adams, *Eurytrochus strangei* A. Adams, *Astelena scitula* A. Adams, *Notoacmea petterdi* Ten.-Woods, *Tectarius tuberculatus* Menke, *Baryspira fusiformis* Petterd, and *Xymene hanleyi* Angas; many of the Peronian species now distinguished, also occur at Mallacoota, as *Rhyssoplax jugosa* Gould, *Ischnochiton crispus* Reeve, *Callistochiton antiquus* Reeve, *Emarginula hedleyi* Thiele, *Haliotis naevosum* Martyn, *Gena impertusa* Burrows. It may be noted that Roy Bell collected over two hundred species of marine mollusca in the Mallacoota district, which I hope to report upon soon, as previously there is scarcely a record at all.

SOLEMYA AUSTRALIS Lamarck, 1818.

Solemya australis Lamarck, Hist. Anim. sans Verteb., v., 1818, p. 489, King George's Sound, Western Australia.—*Mya marginipecta*, ib., ex Peron MS., in synonymy.

Three young specimens of a *Solemya* were picked out of dredgings made in 6-12 fathoms in Twofold Bay, and these are provisionally referred to the above-named species, until series are collected and the locality given by Lamarck confirmed. I find similar young specimens in the Australian Museum, collected by Hedley and Brazier in Middle Harbour, Sydney, and these do not exactly agree with juveniles collected in King George Sound by Prof. Dakin also in the Australian Museum.

The genus *Solemya* was introduced by Lamarck with this species and *S. mediterranea*, and Gray (Proc. Zool. Soc. Lond., 1847, p. 192) named the latter as type. Dall, reviewing the group (Nautilus, xxii., 1908, p. 2) cited the former, and this error has been copied by Suter. According to Dall's classification this adds a superfamily Solenomyacea as well as a family Solemyacidae to the New South Wales List.

* (5) NUCULA PUSILLA Angas, 1877.

From the description and figure, this species appeared to be a *Pronucula*, and comparison of specimens I have collected on the Sydney beaches confirms this, necessitating its transference to that genus.

(6) NUCULA UMBONATA Smith, 1891.

When Smith named this species, he overlooked the fact that J. Hall (Nat. Hist. New York, Palaeont. v., 1885, pt. 1, p. 321) had appropriated the name.

* These numbers refer to Hedley's Check List.

Smith did not describe the hinge, but it is a true *Nucula* so I rename it *Nucula praetenta*, nom. nov.

(7) NUCULANA CRASSA (Hinds, 1843.)

Described from "Australia" only; the type is a large shell agreeing with Tasmanian shells named *chuva* by Gray, collected by Jukes at Hobart. I therefore select Hobart, Tasmania, as the type locality of *crassa* Hinds. Twofold Bay shells are smaller and less coarsely sculptured, and this small form reaches north to Caloundra, Q'ld. If a name be desired, *hanleyi* is available.

(8) NUCULANA DOHRNI (Hanley, 1861). (Plate xxxv., figs. 14-15.)

Leda hanleyi Angas, 1873, is not a synonym of this species as given by Hedley, but is referable to the preceding (*N. crassa* Hinds) as will be seen from the description and figure, and which I have verified from examination of the type tablet preserved in the British Museum (Nat. Hist.), which is, moreover, labelled "*N. crassa.*"

Sowerby (Conch. Icon. (Reeve), xviii., Nov., 1871, Laeda, Pl. ix., sp. 54), figured "*Laeda dorhnii* (sic) A. Adams. Hab ?" "Mus. Cum. in Brit. Mus.," probably from the same specimen, but the figure is very poor as it does not show the elegant elongate shape of this species commonly occurring in shallow water, 15-25 fathoms, in Twofold Bay (Pl. xxxv., fig. 14). From deeper water, 50-70 fathoms, off Green Cape, specimens were secured which differed from the preceding in shape, agreeing better with Sowerby's figure, and which may be shortly described as having the shape of *N. crassa*, with the sculpture of *N. dohrnii*. These I name *Nuculana* (*dohrnii*) *tragulata*, nov. (Pl. xxxv., fig. 15).

By this nomination, which I have referred to in my introductory remarks, I indicate the relationship of the species without dogmatising as to the absolute value of the observed difference. I note that the form described appears to be the deepwater relative of the shallow water *N. dohrnii*. *Leda woodsii* Tate (Trans. Roy. Soc. S. Aust., viii., 1885 (May, 1886), p. 133, Pl. ix., f. 8), from the Muddy Creek, is almost inseparable from *N. dohrnii* according to Tate himself, and its status would be shown by using the combination *Nuculana* [*dohrnii*] *woodsii*, while *Leda crebrecostata* Ten.-Woods (Proc. Roy. Soc. Tas., 1886 (1887), p. 112), as figured and described by Tate (loc. cit., p. 133, Pl. v., figs. 5a-b), appears to approximate very closely to the deepwater form here described, and this might be recorded as *Nuculana* [*crebrecostata*] *tragulata*, or *Nuculana* [*dohrnii*] *crebrecostata* might be used for the fossil form.

(11) NUCULANA MILIACEA (Hedley, 1902.)

This peculiar little smooth species is very different in appearance from the normal forms, so I provide the new genus *Comitileda* and name it as type.

(14) POROLEDA ENSICULA (Angas, 1877).

The elimination of all errors from a trebly-confused subject is a matter of great difficulty. In the present case, the specific identities have been correctly recognised with regard to the Australian species, but I propose to separate these generically and thus, perhaps, obviate further error. Hedley, dealing with bivalves dredged in 110 fathoms in New Zealand waters (Trans. N. Z. Inst., xxxviii., 1905 (June, 1906), p. 71, Pl. ii., fig. 7), gave the correct quotation for the introduction of the genus name *Poroleda*, Hutton, Macleay Mem. Vol., Linn. Soc. N.S.W., p. 86, Sept., 1893 (ex Tate MS.), figuring a recent shell doubtfully identified as agreeing with the fossil type, *Scaphula ? lanceolata* Hutton, Trans.

N.Z. Inst., xvii., 1884 (1885), p. 332. Suter (Man. N.Z. Moll., 1913, p. 840) has remarked upon the different size and proportions of the recent shell, so it seems as well to name the species figured and described by Hedley as above; so I here rename the 110 fathom shell *Poroleda pertubata*. *Poroleda spathula* Hedley generally agrees with this species in the nature of the teeth, but Angas's *Leda ensicula* shows teeth of a different formation, though the shell is similarly elongated. I propose the new genus *Propeleda*, naming *Leda ensicula* Angas as type. Thiele's Antarctic *Leda longicaudata* (Deutsch. Sudpol. Exped., xiii., 1912, p. 229, Pl. xvii., fig. 22), as determined by Hedley from the Shackleton Iceshelf, Antarctica, is actually congeneric with this, and not a *Poroleda* as here restricted. The two species, *ensicula* and *spathula*, occurred together in Twofold Bay in 20-25 fathoms, but the majority belonged to the former species. In a deeper dredging off Green Cape, in 50-70 fathoms, many specimens turned up, but at this depth *spathula* predominated. This suggests that the latter is a deeper-water shell and this is confirmed by the series in the Australian Museum. *P. spathula* varied a little in shape, the larger ones, some exceeding the type in size, agreeing with Hedley's first figures, the smaller ones being more like the later painting made by Miss Clarke.

(23) Lissarca picta (Hedley, 1899).

The generic name *Austrosarepta*, proposed by Hedley for this species, should be revived, as more material and study of Antarctic material shows this genus to differ materially from, though superficially resembling, the Antarctic and Subantarctic *Lissarca*.

Another item of interest is that No. 31, *Bathyarca perversidens* Hedley, should be placed after No. 17, *Cucullaea concamera* Bruguière, as it appears to be the southern degenerate deepwater relation of the tropical *Cucullaea*, agreeing in most essential features. Johnston described a *Cucullaea minuta* (Proc. Roy. Soc. Tasm., 1879 (1880), p. 40: Table Cape, Tas.) which name attracted me, but from the description it seems more like a *Limopsis*, such as *L. erectus* Hedley and Petterd (Rec. Austr. Mus., vi., 1906, 224, Pl. xxxviii., figs. 14 and 15, from 300 fathoms, off Sydney).

(26) Arca fasciata Reeve, 1844.

Some years ago Hedley suggested that *Arca pistachia* Lamarck referred to the shell described by Smith as *Arca* (*Barbatia*) *radula* (Adams MS.) in the Challenger Reports (Lamell., 1885, p. 260, Pl. xvii., figs. 3, 3b). Smith's specimens came from Station 162; off East Moncoeur Island, Bass Straits, 38 fathoms, which he identified with Adams's shell localised as "Hudson's (i.e., Hobson's) Bay, Port Philip (sic), South Australia (recte Victoria) on seaweed 4½ fathoms." Smith had overlooked the fact that Lamarck had described his species from almost the same locality, Ile King, but protested (Journ. Malac., xii., pt. 2, p. 27, June 29, 1905) that Lamarck's description was just as applicable to *Arca fusca* Bruguière or *A. fasciata* Reeve. Hedley searched, when in Europe, for Lamarck's shells without success and then acquiesced in Smith's rejection. Still more recently Lamy, studying *Arca* as a group, determined Smith's *radula* as simply a variety of Reeve's *fasciata*. This conclusion was accepted by Hedley who, therefore, used Reeve's name. This proves untenable, as Reeve had been anticipated by Schroeter (Archiv. Zool. (Wiedemann), iii., pt. 1, 1802, p. 129), so the matter must be reopened.

The description given by Lamarck agrees very exactly with the shells I

have received from Twofold Bay, the "extus grisea, intus fusco-nigricante," "ses valves sont striées à l'intérieur" being descriptive, and I accept Lamarck's name without hesitation, especially as he also included in his list of *Arca, fusca* Bruguière. Lamarck's specimens were in the Paris Museum, so it may be that the specimen noted by Lamy, labelled "*barbata* Lamarck," as *fasciata* Reeve is one of the original lot. As Lamy has pointed out (Journ. de Conch., lv., 1907, p. 51, footnote) *Barbatia adolphi* Dunker (Novit. Conch. (Pfeiffer), 2nd ser., pt. xiii., 1868, Pl. 37, figs. 1, 2, 3, p. 107) collected in Australia by Preiss seems related to, if not identical with, this species, and this name has priority over Smith's *radula*, the type locality apparently being south-west Australia, whence Preiss's specimens were sent.

Australian Arcas still require revision, as Lamy's treatment does not completely cover the points at issue. Thus the acceptance of a worldwide range for many species has already been disputed successfully by E. A. Smith and Hedley and consequently for No. 24, Gmelin's *afra*, given to a Senegal shell, should be eliminated from an Australian catalogue. Lamy states that Lamarck's *Arca pisolina* (Anim. s. Vertcb., vi., p. 41, July, 1819: mers de la Nouvelle Hollande) is based upon small specimens he regarded as equivalent to *A. sculptilis* Reeve, and Lamarck's name would be preferable to Gmelin's.

For No. 30 an earlier reference is to *Arca trapezia* Deshayes (Rev. Zool. Soc. Cuv., ii., p. 358, Dec. 1839: "Sem Blas, Mexico" error ?). Hedley has discussed this name and has agreed to the decision, but Lamy, in confirming this, has noted that he has seen specimens from Panama which again suggest doubt; but Deshayes' figure is very like our shell.

(32) GLYCYMERIS AUSTRALIS (Quoy and Gaimard, 1834). (Plate xxxv., figs. 3, 18-20).

Pectunculus australis Quoy and Gaimard, 1834, clashes with *P. australis* Morton (Synops. Org. Remains Cret. Group, U.S., 1834, p. 64). The preface to the latter work is dated Jan. 1, and it is believed to have appeared early in that year, while there is no definite record of the publication of Quoy and Gaimard's essay in 1834. I, therefore, reject Quoy and Gaimard's name, as there are numerous other names for the Australian shell. Hedley has included as 32 A, *G. australis flammeus* Reeve, a colour variety he had collected at Twofold Bay some twenty years ago. May has recently added this variety to the Tasmanian fauna as occurring on the Furneaux Group, noting it also from Lakes Entrance, Gippsland, Victoria. Roy Bell sent me scores of washed-up valves and a few complete specimens in good condition from the Victorian locality. These showed a little variation in shape and sculpture, and, upon comparison at the British Museum, I noted several synonyms. A series dredged by Bell in shallow water at Port Fairy, Victoria, were mostly small and covered with a dark brown periostracum, those from Lakes Entrance being practically naked. These appeared separable and were regarded as *striatularis* Lam. Then, from Twofold Bay, Roy Bell sent many magnificent examples dredged at various depths, some naked, some fully clothed. The larger, thicker shells were generally unclothed, the thinner shells fully covered: they showed obliquity in shape, but some of the young ones were regular. The fully clothed ones frequented the deeper water and never appeared to become so obese as the naked heavier shells, of which larger specimens still were sent from Disaster Bay in shallow water. From the shallow-water dredgings in Twofold Bay small shells, fully clothed, of varying shape and sculpture, were picked out. Then a series of small, almost

trigonal, shells were sent from a dredging made in 5-12 fathoms off Gabo Island, Victoria. Close criticism of the British Museum material showed that, while all these generally agreed in the hinge teeth (Pl. xxxv., figs. 18 and 20), a striking difference was seen in specimens from Sydney northwards in New South Wales, when the hinge was examined, the teeth being more numerous and more closely set together (Plate xxxv., f. 19). These agreed with *Pectunculus holosericus* Reeve (Conch. Icon., Vol i., Pectunculus Vol. iv., sp. and f. 18, March, 1843) from Australia: type in Brit. Mus. ex Mus. Cuming. Specimens dredged by the *Challenger* in Sydney Harbour, and by the *Rattlesnake* in Broken Bay, agreed with the type, and the velvety epidermis is a striking feature. Pritchard and Gatliff (Proc. Roy. Soc. Vict., xvii., Sept. 1904, p. 244) had cited *P. holosericus* as a synonym of *striatularis*, but it is very different in many ways. None of my specimens agreed with *P. holosericus*, but I collected shells at Caloundra that came close but did not agree exactly, and these were differentiated by Lamy (from specimens sent by Hedley) as *P. hedleyi* (Journ. de Conch., lix., 1911 (5 Feb. 1912), p. 123, Pl. ii., figs. 6, 7) from Bundaberg.

Mr. A. E. J. Thackway collected a series of valves at Port Stephens, New South Wales, which showed three distinct species, and then found the same three at Narrabeen. I collected some hundreds of valves on the latter beach, and found they could be easily separated and that the characters of each could then be gauged. This series illumined the Twofold Bay collection and I think I can represent the facts correctly as follows:—

Bundaberg to Caloundra, Queensland.

G. hedleyi Lamy.

Port Stephens to Sydney.

G. holosericus Reeve.

These appear to be closely allied and I have no record further south yet.

Mast Head Reef, Queensland.

G. queenslandicus Hedley.

Moreton Bay to Sydney.

G. crebreliratus Sowerby.

Twofold Bay to Port Phillip, Vic.

G. tenuicostatus Reeve.

These appear to be related very closely.

G. flammeus Reeve seems to range from Port Stephens to Lakes Entrance, Victoria, and the Furneaux Group, Tasmania, the synonyms being *P. grayanus* Dunker (Proc. Zool. Soc. Lond., 1856 (8 May, 1857), p. 357): New Zealand (error) and *Axinaea kenyoniana* Brazier (These Proc., xxii., 1897, p. 781 from Lakes Entrance, Victoria.

G. flammeus is the largest and heaviest; broadly oblique, practically denuded of periostracum, hinge-teeth few and distant. *G. holosericus* never grows quite so big, but is still heavy, almost regularly orbicular, but when senile higher than broad, a velvety periostracum which is persistent, and the hinge-teeth numerous, set close together and in a roundly arched line. *G. crebreliratus* is much smaller, thinner, circular but semi-beaked posteriorly, sculpture stronger, with periostracum semi-persistent and not so velvety. *G. tenuicostatus* is similar, more trigonal in shape, more obese and thicker, sculpture still stronger and periostracum persistent and less velvety: teeth closer than those of *flammeus*, but not so close as those of *holosericus*.

The Tasmanian shells referred to *striatularis* Lamarck by local workers were not determined exactly by E. A. Smith in the British Museum, as they did not

agree with typical shells from King George Sound (Hist. Anim. s. Verteb., vi., July, 1819, p. 52). Specimens, above referred to, as being thinner and fully covered and more oblique, from Twofold Bay, agree very closely with southern Tasmanian shells, and Lamy (Journ. de Conch., lix., 1912, p. 112, Pl. ii., figs. 1-2) has figured a Tasmanian specimen for comparison with Lamarck's type (also figured). The series I secured on the beach at Port Fairy, Victoria, are heavier shells, more obese, with the teeth in the hinge more closely set, and approximate more closely to the type. I regard these as the eastern limit of the typical form, and propose to name the Twofold Bay and eastern Tasmanian series, figured since also by May (Illustr. Index Tasm. Shells, 1923, Pl. ii., f. 8) subspecifically as *Glycymeris striatularis suspectus* nov. (Plate xxxv., fig. 3).

Study of Muddy Creek and Table Cape fossils, in conjunction with long series of recent shells as above determined, would prove very interesting, as the shells in the British Museum labelled *G. cainozoicus* Ten.-Woods are of different shape, size, and teething and appear to include ancestral forms of more than one of the species above determined.

The corrections and additions to the New South Wales list would read:—

32 and 32 A *Glycymeris flammeus* Reeve, 1843 = *australis* Quoy and Gaimard, 1834 *not* Morton, 1834 = *grayanus* Dunker, 1856 = *kenyoniana* Brazier, 1898.

32 B *Glycymeris holosericus* Reeve, Conch. Icon., Vol. i., Pectunculus, Pl. iv., sp. and fig. 18, March, 1843: Australia: Brit. Mus. ex Coll. Cum., type probably from Sydney District.

33 *Glycymeris gealei* Angas, 1873.

33 A *Glycymeris flabellatus* Ten.-Woods, Proc. Roy. Soc. Vict., xiv., 1877 (11 July, 1878), p. 61: Victoria = *P. orbicularis* Angas, 1879: Bass Straits = *P. beddomei* E. A. Smith, 1885, as dealt with in the succeeding note.

33 bis error = 34 *Glycymeris tenuicostatus* Reeve, 1843.

34 A *Glycymeris crebreliratus* Sowerby, Journ. Linn. Soc. Lond., Zool. Vol. xx., 1889, p. 399, Pl. xxv., f. 20: Moreton Bay, Q.

34 B *Glycymeris striatularis suspectus* here named. Lamy, Journ. de Conch., lix., 1912, p. 112, Pl. ii., figs. 1-2; May, Illustr. Index Tasm. Shells, 1923, Pl. ii., f. 8.

(33) Glycymeris gealei (Angas, 1873).

This species was described from Port Macquarie, New South Wales, and the type is in the British Museum (Natural History). It is a very obese, trigonal shell and does not appear to have been met with since: it agreed fairly closely in shape and sculpture with specimens sent to the British Museum by Sir J. Verco as *sordidus* Tate from South Australia. The hinge-teeth are also similar, so it was suggested that the N.S.W. locality might be erroneous, but I have collected a valve on the beach at Narrabeen proving its distinction and correct locality. Roy Bell sent me a specimen of a ribbed *Glycymeris* from Lakes Entrance, Victoria, and then dredged a few nice specimens alive in 10-20 fathoms in Disaster Bay, and a valve was picked out of 20-25 fathoms dredging in Twofold Bay. These agreed very exactly with the types of *P. orbicularis* Angas (Proc. Zool. Soc. Lond., 1879, p. 420, Pl. xxxv., fig. 9) from Bass Straits, and *P. beddomei* E. A. Smith (Voy. Challenger, Zool. Vol. xiii., 1885, p. 252, Pl. xviii., figs. 1-1b), also from Bass Straits, 38 F., and these are regarded as synonyms of *P. flabellatus* Ten.-Woods (Proc. Roy. Soc. Vict., xiv., 1877 (11

July, 1878), p. 61), from Victoria. This was unfigured until recently when May (Illustr. Index) figured, under Tenison-Woods's name, the same shell. The matter is more complicated than here appears as Verco used, for the South Australian shell, *G. pectinoides* Deshayes, remarking upon the great variation. Lamy rejected *pectinoides,* to my view correctly, but records Verco's *pectinoides* as referable to *flabellatus,* not to *sordidus,* which he included as distinct. As a synonym of the latter, he suggests, following Hedley, *G. insignis* Pilsbry (Proc. Acad. Nat. Sci. Philad., 1906 (24 July, 1916), p. 213, fig. in text) from Geographe Bay, Western Australia. On account of the more numerous hinge-teeth I should allow Pilsbry's species distinction, as the Western representative, until more specimens have been collected. There appear to be two species, one trigonal with few teeth, one orbicular with more numerous teeth, and these are commonly represented among fossil collections, the former under the name *subtrigonalis* Tate, the latter under the name *laticostatus* Q. and G. from New Zealand, but which differs at sight from the N.Z. species by the closer crenulations of the edges of the valves and which should bear the name *maccoyi* Johnston.

(44) ISOGNOMON CUMINGII (Reeve, 1858).

This, of course, did not occur in the Twofold Bay collection, but I wish to make a note regarding the generic name *Isognomon,* for whose recent acceptance I was responsible (Proc. Malac. Soc. (Lond.), xi., 1915, p. 303). I there observed "I have not yet noticed Solander's usage of *Pedalion,* and it may be that Gray's was the first introduction of it. It is obviously equivalent to Solander's *Isogonum* as here discussed.." I have since noted that Dillwyn (Descr. Cat. Recent Shells, 1817, p. 281-282) wrote in synonymy *"Pedalion perna," "Pedalion isognomon," "Pedalion ephippium"* as of Solander's MSS., in connection with the first-named citing "Portland Cat. p. 52, lot 1242" and adding "was arranged by Dr. Solander in the Portland Cabinet under the name of *Pedalion torta."* None of these names is found in the Portland Sale Catalogue, and *Pedalion* only dates thus from 1817. In the Linnean Index to Huddesford's edition of Lister, published in 1770, I find the entry (p. 23): *"Ostrea epphippium. Pedalion.* Rudder. Solander." If this be acceptable *Pedalion* Huddesford will replace *Isognomon.*

(48) PTERIA PULCHELLA (Reeve, 1857).

This name, used by Angas, was accepted by Hedley without criticism, and, unfortunately, May has used the name in his Illustr. Index, though figuring a Tasmanian shell. The latter had, however, an earlier name, having been named *Avicula hyalina* Dunker (Zeitschr. fur Malak. (Menke), Jr. 9, No. 5, June, 1852, p. 75) and figured in the Conch. Cab. (Kuster), Bd. 7, Abth. 3, 1872, p. 32, Pl. 10, figs. 3-4, where *A. scalpta* Reeve was synonymised. *A. pulchella* Reeve was published in the Conch. Icon., Vol. x., Avicula sp. and f. 22, Pl. viii., March, 1857, from the Philippine Islands, while *A. scalpta* was sp. and f. 38, Pl. xi., from Australia. The type of the former in the British Museum did not exactly agree, while the latter was identical with shells from shallow water, Twofold Bay, and from Lakes Entrance, Victoria. Previous to Dunker, however, Quoy and Gaimard had named *Avicula georgiana* (Voy. de l'Astrol., Vol. iii., 1835, p. 457, Pl. 77, fig. 10-11) from King George's Sound and this appears the name to be used, unless the shell from the eastern coast can be differentiated, which appears a difficult matter in a variable featureless shell.

Lamarck had described *Avicula papilionacea* (Hist. Anim. s. Verteb., Vol. vi., July, 1819, p. 149) from "les mers de la Nouvelle Hollande. Péron Mus no"

citing as illustrations "Chemn. Conch., 8, t. 81, f. 726" and "Encylop., Pl. 177, f. 5," the latter being a copy of Chemnitz's figure. This name has been used for the species here discussed, but Deshayes, in the 2nd edition of Lamarck (Vol. vii., 1836, p. 100) noted that the shell in the Museum was a distinct species from that figured by Chemnitz, which Lamarck had quoted, and that he could not quote any good figure like Lamarck's shell. Apparently he had one prepared simultaneously, as in his Elem. Traité de Conchyl. (plate dated 1835, but not published until 1850) Pl. 40, figs. 7-8, a good figure named *Avicula papilionacea* Lamarck is included. This proves that the name has nothing to do with the species now under review.

The generic name *Electroma* Stoliczka (Pal. Indica, iii., 1871, p. 391), provided for *A. smaragdina* Reeve, should be used for this group as in the Coll. Brit. Mus.

(52) Vulsella vulsella (Linné, 1758).

Smith's revision at the place quoted by Hedley allowed *Vulsella spongiarum* Lamarck as a distinct species from Southern Australia. As Smith, throughout that revision, used genetic features as specific characters, there should be little hesitation in allowing this form specific rank.

The name *Vulsella* was used, previously to Lamarck in 1799, by Humphrey in the Museum Calonnianum in a different sense, so must be here rejected.

Swainson proposed *Reniella* (Treat. Malac., 1840, p. 386). for a new species, *Reniella dilatata*, fig. 127, which is only an abnormality of the species *V. vulsella* Linné, so that Swainson's generic name will come into use.

(53 and 55) Ostrea angasi Sow., 1871 and Ostrea virescens Angas, 1867.

Mr. Hedley has suggested to me that these two names refer to the same species, and upon his proposal May had used the latter name; however, Mr. Hedley has indicated a still earlier name and allowed me to publish this account.

When Peron's account of his travels appeared (after his death), in Vol. ii., 1816, p. 80, is written "Annoncer que l'ile Decrès a pu fournir à mes collections trois cent trente-six espèces de Mollusques, de Crustaces &c., c'est dire assez qu'il me seroit impossible d'entrer dans de longs details sur cette multitude d'animaux; je me bornerai donc à présenter quelques-uns des principaux résultats de mes observations en ce genre. I. A. l'entrée du petit port Daché, on trouve une grande espèce d'Huitre, qui forme sur ce point des bancs très-étendus: *la chair de cet animal est tendre et délicate.*"

Lamarck described several species of *Ostrea* from the seas of New Holland without naming the collector, so that it is even doubtful if the exact locality be given. Some small species are named, such as *O. numisma,* of which Hanley wrote "having been founded on a single wretched specimen in the (Paris) Museum which is destitute of any decided characters, should be expunged from our catalogues."

However, Lamarck's *Ostrea sinuata* (Hist. Anim. s. Verteb., Vol. vi., July, 1819, p. 208) is well described and compared to the European *O. edulis*, a convincing factor, inasmuch as to within very recent years the Australian and New Zealand oysters were regarded as only varietally distinct from that species.

Of this species Hanley wrote (Illus. and descr. Cat. Rec. Bivalve Shells. 1856, p. 300) "An examination of the type at the French Museum proves that the characters upon which this species has been founded are purely accidental: the name ought, consequently, no longer to be retained in our catalogues, the shell being practically undefined." As Hanley's translation of Lamarck's diag-

nosis was incorrect, and as he did not say what else Lamarck's species was (probably thinking of *edulis*), we need not obey his dictum.

From this conclusion, *Ostrea sinuata* Lamarck is the name for the shell recently known as *O. angasii* from Australia. The Neozelanic species known by the latter name seems to be a distinct species. The status of *O. virescens* Angas I have not yet decided.

(54) Ostrea cucullata Born, 1778.

This species was described from the Mus. Caes. Vindob. without locality, but, when figured in the later work, the locality was given as West Indies and the Isle of Ascension and is still included in lists of these faunas. As there appear to be two forms in New South Wales, the name may be totally rejected. On the sheltered shores and with the mangrove associations is a form named by Gould *glomerata*: this appears to range further south, and Roy Bell sent it from Tellaburga Island, off the Victorian corner, which seems to be an addition to the Victorian fauna. The other form, which lives on the ocean reefs extending as far south as Long Reef, near Sydney, and which Bell collected at Lord Howe Island, may bear the name of *mordax* Gould. These names were proposed by Gould (Proc. Bost. Soc. Nat. Hist., iii., Dec., 1850, p. 346) for shells from New Zealand and the Feejee Islands respectively, and may later have to give way to some earlier name, as Solander appears to have collected specimens when here with Captain Cook, probably at Cooktown. Thus, in the Sale Catalogue of the Portland Museum, appears the entry on p. 139, etc., "*Ostrea purpurea* S. from New Holland, very rare."

The name *O. purpurea* falls as an absolute synonym of Born's *O. cucullata*, as Born's figures (Tab. 6, f. 11-12) were cited as illustrative of Solander's species.

(56) Neotrigonia margaritacea (Lamarck, 1804).

A large series dredged in 15-25 fathoms showed that little variation occurs in this genus, and that, in view of the lineage of the group, the observed differences may be regarded as of specific value. Thus, although Lamarck named King Island as one of the localities, Peron mentioned that he picked up the first specimens at Adventure Bay, South Tasmania. This may, therefore, be fixed as the type locality of Lamarck's species, and a series from Port Arthur, South Tasmania, are like the Twofold Bay shells, averaging a little larger, sculpture more spinose, beak still a little longer proportionately, and generally more compressed, but, to me, certainly conspecific. A long series in the Australian Museum, from Port Jackson, show these to be more solid though smaller, and to have a more acute beak with much less spinose sculpture, and these I regard as specifically distinct. Verco's *T. beddomei* is not easily confused, and I also separate this specifically without any hesitation. The deepwater forms are also separable and, so far, I have seen no large shells. Tenison-Woods proposed *Trigonia lamarckii* var. *reticulata* for specimens dredged in 45 fathoms off Port Jackson Heads, and notes "the shell is small and thin." For this, recently, the name given by McCoy to a fossil, *acuticostata*, has been used, but my criticism of fossils leads me to conclude that these show more variation than the recent shells, and in the British Museum collection two entirely different species, one from Muddy Creek, the other from Bairnsdale, are both named *acuticostata*. Of two specimens from Muddy Creek labelled *howitti* McCoy, one is very like the Twofold Bay *margaritacea*, the other is much more elongated and quite distinct in appearance.

The juvenile sculpture has been investigated by Hedley and T. S. Hall, and I note that it persists longer in the southern shells than in the northern, and is followed by a flattened scale sculpture, which is soon lost in the normal eastern forms, is practically retained in the South Australian *beddomei*, and is exaggerated in the bizarre *strangei*.

(56a) NEOTRIGONIA GEMMA, n.sp. (Plates xxxiii., figs. 1-2; xxxv., f. 1).

Shell small, for the genus, triangularly ovate, scarcely inaequilateral, obese, rather solid, easily separable by its small size and shape. The radials number about twenty-two, each with about twelve triangular projections, easily counted from the edge, diminishing rapidly in size after that, and becoming less pointed: the interstices are finely lined. The ribs are finer on the posterior side, which is little produced and simply indicated by an angle, but medially a little depressed. The juvenile discrepant sculpture is well marked and the hinge is strong for the size. Length 14 mm.; breadth 14 mm.

Dredged as dead valves commonly in 50-70 fathoms, off Green Cape, N.S.W., a few young live ones among them.

Trigonia reticulata Agassiz (Etudes foss., 1840, Pl. 11, f. 10) anticipates Tenison-Woods's name, as I find topotypical specimens of the latter form come very close to my shell, though the description did not agree. Plate xxxiii., figs. 1-2 show *N. gemma* contrasted as to shape with young of *N. margaritacea* Lam. of same size.

(58) PECTEN MEDIUS Lamarck, 1819.

Inasmuch as this name must be abandoned it may be of interest to record my results. I find that there is geographical variation, and that probably the variation is of specific value. The Peronian shells are more orbicular, the right valve deeper and the ribs rounded and unsculptured between: the Tasmanian and Neozelanic shells are larger, more oval, the right valve shallower, the ribs of the former square and with thread lines between. This is practically in agreement with Tate's results, who also separated the South Australian shell as a variety only of the New South Wales form.

Tate (Proc. Roy. Soc. Tasm., 1886 (1887), pp. 113-116) reviewed the species and distinguished:—

Pecten fumatus Reeve for the New South Wales shell; var. *albus* or *P. albus*, South Australian; *meridionalis*, Tasmanian; and *laticostatus* for the New Zealand shell.

As the last name proves to be preoccupied, Reeve's *novaezelandiae* will come into use, but Tate's other names will remain.

Thus, *Pecten medius* is anticipated by Bosc (Hist. Nat. Coquille, Vol. ii.; Hist. Nat. Buffon, ed. Deterville, Vol. 59, 1802, p. 275) who also introduced *Pecten fuscus* (p. 263) and *Pecten modestus* (p. 277). This leaves, as the oldest name, *Pecten fumatus* Reeve (Conch. Icon., Vol. viii., Nov., 1852, sp. and f. 32) from Sydney, so that this name is unquestionable, whether the other forms be regarded as varieties or species.

The series dredged in Twofold and Disaster Bays, 10-20 fathoms, show some interesting variation, as some have the interstices between the ribs on the convex valve smooth, while others have the interstices strongly striated: one specimen is smooth until two-thirds grown, then striate. However, I believe that all the southern shells tend to show striation, while the northern ones are smooth. Many specimens have recently been studied, strongly supporting the view that the

observed differences are of specific value, while deepwater shells from off Twofold Bay are near the Tasmanian species. With regard to the generic name *Pecten*, it may be noted that Sherborn has included in the Index Animalium, 1901, p. 1156, the entry "*Pecten* P. Osbeck, Reise Ost. Ind. China, 1765, p. 391," and, that this is a nomen nudum, has been recorded by Dall. Using Forster's translation published in 1771, Osbeck wrote (Vol. ii., p. 100) "With the cable we pulled up a piece of coral, on which a red shell (*Pecten adscensionis*) was growing, which on its valves represented many branches. We took it with us, and at present it is preserved in one of the greatest cabinets of natural curiosities in *Sweden*." If this be regarded as descriptive it is suggested that the shell named by Osbeck was a *Spondylus*.

(65) CHLAMYS HEDLEYI Dautzenberg, 1901.

This species was dredged in 50-70 fathoms off Green Cape, and from recent dredgings by the Australian Museum Officials it appears to be a constant deeper water species. The name given by Dautzenberg must be rejected and Hedley's name *fenestrata* be resumed, as Forbes's name does not clash in any sense to-day.

(65 A) CHLAMYS UNDULATUS Sowerby, 1842.

Pecten undulatus Sowerby, Thes. Conch., Vol. i., 1842, Pecten, p. 60, Pl. xix., f. 206, 207; Mediterranean ? = Australia.

A valve of this species was picked out of the shallow water dredgings from Twofold Bay, and on critical comparison was found in agreement with the (supposed) type of this species, and quite different from type of Angas's *tasmanicus*, with which it has sometimes been confused.

(74) LIMA ANGULATA Sowerby, 1843.

This species was described from Panama, and it is fortunate that the name is invalid, being used previously by Münster (Beitr. Petref. Kunde, Vol. iv., 1841, p. 73, Pl. 6, f. 30). Angas used *Lima orientalis* Adams and Reeve for this species, and this name is also included by Hedley (No. 78), though only one species is intended, and may be retained.

(75) LIMA AUSTRALIS Smith, 1891.

This would have been placed under *Limea*, but as it represents a distinct development from the fossil European type of *Limea*, and many species of deep-water relations are known, I propose the new genus *Notolimea*, naming *L. australis* Smith as type.

The species, *L. murrayi* Smith, inadvertently placed under *Limea* by Hedley (No. 81), should be transferred back to *Lima*, *sensu lato*, placed next to *L. orientalis* Ad. and Reeve, being referable to the section *Mantellum*, as Thiele has already pointed out.

(77) LIMA MULTICOSTATA Sowerby, 1843.

The species bearing this name has been often regarded as a form of *Lima lima* (Linné), the latest authority to do so being Thiele (Conch. Cab. (Kuster), Vol. vii., 1920, p. 20).

I had, however, recorded it from the Monte Bello Islands (Proc. Zool. Soc. Lond., 1914, p. 666) living alongside a form of *Lima lima* (Linné), and being a quite distinct species.

Roy Bell sent many specimens, and I find it to be a very common shell here, dead shells abounding on all the beaches, and live ones, generally young,

attached by a byssus to the under sides of stones in rock-pools. Though very variable in shape, nothing like *L. lima* has been met with, and no intergradation is known.

The original locality of Sowerby's species was unknown, probably the Mediterranean Sea, and it has been recorded from other localities. As the name proposed by Sowerby had been previously used by Geinitz (Charak-Schichten Petref-sachs Kriede, Vol. i., 1839, p. 24, Pl. 8, f. 3) I am describing Roy Bell's specimens as a new species.

(77) Lima nimbifer, n.sp. (Plate xxxiv., figs. 1-4).

Well known under the name of *Lima multicostata* Sowerby, and sometimes regarded as a variety of *Lima lima* (Linné).

Shell somewhat variable in shape, obliquely subovate, sometimes more rounded, sometimes irregularly elongated, rather compressed, fairly solid, white. Anterior side straight, with an excavate lunule, rayed longitudinally, a few faint cross lines sometimes showing; posterior side short, produced into an auricle similar to the anterior auricle and then, after a sinuation, sweeping boldly into a rounded margin. Hinge-line oblique, ligamental area long, lateral margins straight, showing no teeth. Sculpture consisting of about thirty-two ribs, narrow and with narrower interspaces; interspaces in adult smooth, in juvenile transversely striated; ribs in juvenile smooth, in adult bearing more or less regular lamellate projections.

Length of type 32 mm.; breadth 24 mm.; narrow form, length 36 mm.; breadth 20 mm. Common on the littoral of New South Wales.

The deepwater shell known as *L. bassi* Ten.-Woods (given to a fossil) appears to be the benthal representative of this species.

(84) Mytilus planulatus Lamarck, 1819.

In Victoria and Tasmania two species occur, living together, which differ in the character of the hinge teeth. May has recently regarded the larger narrower form as conspecific with the New Zealand *M. canaliculus* Martyn, and suggested that it might have been introduced. I have examined large numbers, and find that the second species commonly occurs also in Victoria, and is naturally endemic. The teeth do not agree exactly in growth stages with those of the New Zealand shell, and there is a name for the Tasmanian shell, *Mytilus tasmanicus* Tenison-Woods (Proc. Roy. Soc. Tasm., 1875, p. 161).

Mytilus planulatus was described by Lamarck from King George's Sound, Western Australia, and before using this name the type should be re-examined. There is a name given to the Sydney shell, *Mytilus obscurus* Dunker (Proc. Zool. Soc. Lond., 1856 (8 May, 1857), p. 360) and figured by Reeve (Conch. Icon., Vol. x., Jan., 1858, Mytilus, Pl. viii., sp. and f. 30).

Oliver recently (Proc. Malac. Soc. Lond., xv., 1923, p. 181) rejected *M. edulis* Linn. from the New Zealand List. This was an obvious conclusion, but he has replaced it by *M. planulatus* Lamarck, giving the range from King George's Sound to New South Wales and Tasmania, in New Zealand from Cook Strait southward, and at Great Barrier Island. He explained that the true *M. edulis* has an expanded lip, or hinge-plate, bearing a row of small teeth, usually four or six in number, while the New Zealand shell (which he calls *planulatus*) has only two or three teeth, placed inside the apex, not on an expanded lip. Reconsideration now appears necessary.

A name given in his synonymy by Hedley, and copied by May, *Mytilus*

dunkeri Reeve (Conch. Icon., Vol. x., Aug., 1857, *Mytilus*, Pl. v., sp. and f. 17), from the Philippine Islands, should be omitted, as it probably refers to a form of *Stavelia subdistorta* Recluz.

(85) BRACHYODONTES HIRSUTUS (Lamarck, 1819).

The acceptance of the generic name appears to be due to Jukes-Browne's Review of the genera of the Family Mytilidae (Proc. Malac. Soc. Lond., Vol. vi., 1905, pp. 211-224), but it is obvious that correction must be made. Jukes-Browne's definition of *Brachyodontes* reads "Anterior margin with several close-set teeth" and under the subgenus *Hormomya*, differentiated by form alone, he placed *hirsutus* Lamk., *rostratus* Dkr. in Reeve, while under *Brachyodontes* s. str. he allowed *menkeanus* Reeve. He then wrote under the genus *Modiolaria* Beck, "I have not paid any special attention to the genus *Modiolaria*."

I find that *hirsutus* Lamarck is apparently a close relation conchologically of the species *barbatus* Reeve and *splendidus* Dunker, which Hedley has placed in *Musculus* (i.e., *Modiolaria* olim) Nos. 92 and 97: that *rostratus* has prominent hinge-teeth, two and one, the muscle scars of *Mytilus* and a peculiar boss arising from the anterior muscle-scar; I do not see the "several close-set teeth on the anterior margin," but in *erosus* Lamarck (= *menkeanus* Reeve olim), above the ligaments, along the anterior side is a long row of small teeth only developed with age, very pronounced in senile shells, missing in juvenile ones. These are clearly seen in the figure of *Mytilus polyodontes* Quoy and Gaimard (Voy. de l'Astrol., Zool., Vol. iii., 1834-1835, p. 462, Pl. 78, f. 15-16), described from New Zealand, but incorrectly, the true locality apparently being King George Sound, Western Australia. For *hirsutus*, Ihering proposed *Trichomya*, adding thereto *Stavelia torta* Dunker, but *Stavelia* should have been used, if these were considered congeneric. As Ihering named *hirsutus* as type of *Trichomya*, that name can be retained as well as *Stavelia*.

Verco has recently described *Modiola penetecta* (Trans. Roy. Soc. S. Aust., xxx., p. 225), pointing out that the "hairlets" were branched like a stag's horn, whereas the "hairlets" in *M. australis* were simple. It is of interest to note that the hairlets are branched in *hirsutus*, also in *Stavelia subtorta* Recluz (= *torta* olim) and in the species of *Musculus*, *barbatus* Reeve and *splendidus* Dunker, for which I propose the new genus *Trichomusculus*, with *barbatus* as type.

Dall has recently proposed to reject *Musculus* Bolten on account of the prior "*Musc.*" of Martyn, but this is stretching a little too far. While there is suggestion that the abbreviation "*Musc.*" would have developed into *Musculus*, there is no proof.

The species included by Hedley (No. 98) as *Musculus subtortus* Dunker, I have collected in the Curl Curl Lagoon, near Manly, and this is a very aberrant form, if any close relation at all. The shell lacks the discrepant sculpture so characteristic of the "Musculus" group, is twisted, one valve partially clasping the other, and has very distinct and peculiar muscle-scars. I, therefore, propose for it the new generic name *Fluviolanatus*.

(86) MODIOLUS ALBICOSTUS Lamarck, 1819.

As there is serious doubt as to the validity of this name, and it is a long story, I propose to name the Australian shell so-called, and figured by May (Illustr. Index Tasm. Shells, 1923, Pl. iv., f. 6), *Modiolus delinificus*, nom. nov.

(87) MODIOLUS ARBORESCENS (Dillwyn, 1817).

As usual with a Chemnitzian name, many complications occur. A species was described by Chemnitz (Conch. Cab., Vol. xi., 1795, p. 251, Pl. 198, figs. 2016, 2017) under the name *Mytilus arborescens*, said to have come from the island of St. Domingo. This was made the type of a new genus *Amygdalum* by Muhlfeldt (Ges. Nat. Fr. Berlin Mag., v., 1811, p. 69) who called the species *Amygdalum dendriticum*. A world-wide range was developed, but Dunker and Reeve named many species which are still shown, without prejudice, in the British Museum. Shells from the Moluccas differ appreciably from the specimens dredged in Twofold Bay, while Western Australian shells are again different, a series from China looking most like mine. Tasmanian shells marked "*beddomei* Pett." agree closely, and I propose to use for the eastern Australian species the name *Amygdalum beddomei* (Plate xxxv., f. 21), which has recently been figured by May (Illustr. Index Tasm. Shells, 1923, Pl. iv., f. 8) under the name *Modiolus arborescens* Dillwyn.

(88) MODIOLUS AUSTRALIS Gray, 1826.

Hedley (These Proc., xlviii., 1923, p. 302) has recently rejected Gray's name as applicable to the southern Australian shell and suggested the usage of *Modiolus areolatus* Gould, given to a New Zealand specimen, regarding the Neozelanic and Australian forms as inseparable. When Lamarck described his *Modiola albicosta* he observed "On en a une variété élargie en spatule" and Tate wrote (Trans. Roy. Soc. South Austr., xx., 1897, p. 49), "*Modiola australis* Gray. This is also *M. albicosta* var. *spatula* Lamarck!"

(88 A) MODIOLUS VICTORIAE Pritchard and Gatliff, 1903.

Modiola victoriae Pritchard and Gatliff, Proc. Roy. Soc. Vict., xvi. (n.s.), Sept., 1903, p. 93, Pl. xv., figs. 1-2: Rhyll, Western Port, 6 Fath., Victoria.

This is an addition to the N.S.W. List, being dredged in shallow water in Twofold Bay.

(93) MUSCULUS CUMINGIANUS (Reeve, 1857).

Tate (Trans. Roy. Soc. S. Aust., ix., 1885-6 (Mch., 1887), p. 106) used this name for a South Australian shell, recording that *Lanistina nana* Dunker (Proc. Zool. Soc. Lond., 1856, p. 365), from Port Lincoln, was evidently the fry, but did not use the latter name though it was published on May 8, and Reeve's did not appear until December, 1857.

The common South Australian *Musculus* of this style is *paulucciae* Crosse (Journ. de Conch., 1863, p. 89, Pl. 1, f. 8; *Crenella*), Gulf St. Vincent, and this name appears in May's Check List Moll. Tasm., published in 1921, but in the Australian Museum Collection Hedley has crossed out *paulucciae*, and substituted *nana* which is correct.

(95) MUSCULUS RECENS (Tate, 1897).

This species, described as a recent member of the fossil genus *Arcoperna*, and *Arcoperna scapha* Verco, a second species, have been transferred to the genus *Musculus*. Investigation of this matter was induced by the receipt of two examples dredged by Roy Bell in from 50-70 fathoms off Green Cape, both live shells, but one badly smashed. They agreed in character with Tate's species, but differed in shape: they recalled *Crenella* in some ways, but did not suggest *Musculus*, the type of which is the N.Z. *impactus*. I think fossil relations have been described under the generic name *Crenella*, but I cannot reconcile their

features with those of *Arcoperna* which is described as 4.5 mm. in height and *solid* whereas *A. recens* was described as 19 mm. in height, thin, translucent and vitreous.

Crenella globularis Tate (Trans. Roy. Soc. S. Aust., viii., 1885 (May, 1886), p. 126, Pl. x., figs. 3a-b), judging from the figure and description, suggests a relationship with *Arcoperna scapha* Verco.

SOLAMEN REX, n. gen. et sp. (Plates xxxiii., f. 15; xxxv., f. 2).

A genus of the Mytilidae (?) perhaps not distantly related to *Crenella*, but of no close relationship to *Musculus*.

The shell is globose, very thin, translucent, equivalve, inaequilateral, umbos a little anterior, obtusely incurved and approximate, white. The anterior margin is sinuate, then forwardly projecting, lower than the posterior which is more curved, the ventral border ovately rounded. Hinge-line very narrow and showing no teeth, but with a semi-internal ligamental groove. The sculpture consists of very fine radials, very closely packed, towards the ventral edge tending to bear scaly projections; growth-lines, which appear at intervals, become more crowded as the shell grows older. Muscular impressions two, the anterior small and ovate, the posterior large and rounded.

Length of type 11 mm.; breadth 8.5; depth of conjoined valves 8 mm.; larger broken shell 18 x 13 mm. Very closely agreeing with *Arcoperna recens* Tate (Proc. Malac. Soc. Lond., ii., 1896, p. 182), but differing in the shape and a little in sculpture.

(101 A) GAIMARDIA TASMANICA (Beddome, 1883).

Beddome describes *Modiolarca tasmanica* (Proc. Roy. Soc. Tasm. for 1882, (1883), p. 168) from Tasmania, and this was figured by Tate and May (These Proc., 1901, Pt. 3 (19 Dec.) p. 439, f. 12) and more recently by May (Illustr. Index Tasm. Shells, 1923, Pl. iv., f. 16). A few valves picked out of the shallow water dredgings in Twofold Bay enable me to add a family to the New South Wales List. As supplementary to my account (Proc. Malac. Soc. Lond., 1914, xi., p. 173) of the confusion between *Modiolarca* and *Modiolaria*, I can add the following information: In the Amth. Bericht, 24 Versamml. Deutsch Naturf. Kiel, Sept., 1846, p. 217, published in 1847, an account of the molluscs named by Beck and Kroyer is given, the new names being recorded. Among these was "*Modiolarca* Gray für die mit *Mytilus discors* L. verwandten Arten." This had been printed in the Tagelblatt, No. 7, for Sept., 23, 1846, on p. 38, where *Modiolarca* Beck is quoted as a new genus for *Mytilus discors* L. In his List Brit. Anim. in Brit. Mus., pt. vii., 1851, p. 119, Gray used *Crenella* for a genus, citing as synonyms, "*Modiolaria* Beck, Loven, I.M., 1846" and "*Modiolarca* Gray, Syn. B.M., 1842, 92, Proc. Z.S., 1847, 199." In the Proc. Zool. Soc. Lond., 1854, p. 108, Gray explained (under the name *Modiolarca*, which he stated was founded on the *Modiola trapezina*, the characters of the family *Crenellidae*, given in the Synopsis B.M., pp. 144, 155, being based on that species). "Two genera have been made out of this word. Dr. Beck, when in this country, made a note that I had called the genus *Modiolarca*; but he appeared to have read it *Modiolaria*, and that name has been used for it. The latter name is now chiefly used for the more oblong *Crenellae*." It is interesting to note also that in the Proc. Bost. Soc. Nat. Hist., 1841 (1843), p. 26, at the meeting of June 2 is the information. "Couthouy presented 'A shell of a new genus, found only on the *Fucus giganteus*, which he has named *Gaimardia fucicola*.'"

(106-123) Families THRACIIDAE and MYOCHAMIDAE.

The Australian shells referred to these two families are so confused and their characters so commingled, that it may be best to drop the former for the present, and refer all the species to the latter, with some emendations. The fact, that there are two series of shells of very similar appearance, has never been fully appreciated hitherto, and has made the recognition of named species very difficult. Firstly, there appears to be no typical *Thracia* in Australia, and, moreover, as in many cases of the early named genera, the exact application of the name (*Thracia*) is not even settled as regards European shells. Then (No. 106) *Thracia anatinoides* Reeve, described from Sydney, has not since been recognised, and it is here suggested, on Mr. Hedley's advice, that it may be based on the Sydney representative of the shell later named *Periploma angasi* Crosse and Fischer, the preceding species in Hedley's List (No. 105). Nos. 107 and 109 appear to refer to the same species, both being described by Smith at the same time, and the differences cited being seen in a series to be individual only, the name *angasiana* having place priority, the name *jacksoniana* falling as a synonym. No. 108 must resume its earlier name *jacksonensis*, as this name is not invalidated by the still earlier *jacksoniana*. No. 110 has not yet been definitely determined, but may be based on a juvenile specimen of 108; no series of either has been collected, while a different species has borne the name *modesta* in most Australian collections: this species I identify as No. 121.

All these show an external ligament, as does No. 114, placed under *Thraciopsis* in the List. I propose for this series the new name *Eximiothracia*, citing *Thracia speciosa* Angas as type, and the new names would read

No. 106 Omit.
107 and 109 *Eximiothracia angasiana* Smith = *jacksoniana* Smith.
108 *jacksonensis* Sow. = *brazieri* Sow.
110 *modesta* Angas, may = *jacksonensis* Sow.
114 *speciosa* Angas.

To this genus belongs *Thracia myodoroides* Smith (Chall. Rep., Zool. Vol. xiii., 1885, p. 70, Pl. 6, f. 6) from Bass Straits, which may even be only the southern representative of *angasiana* Smith. Tate's *Thracia perscabrosa* (Trans. Roy. Soc. S. Aust., 1886 (1887), p. 173, Pl. xv., f. 5), from the Muddy Creek, is very close in all its features. Some of my specimens I even determined as *myodoroides*, while others have the form of *perscabrosa*, so that perhaps we have here another series of zoological, geological and geographical relations. With regard to the succeeding numbers, 111, 112, 113, there is still more confusion, but the results read

No. 111 *Thraciopsis angustata* Angas.
112 Omit.
113 *Thraciopsis elegantula* Angas, not *elegantula* auct.
114 Transferred to *Eximiothracia* (ante).
113a *Thraciopsis elongata* Stutchbury.
113b *Thraciopsis peroniana*, nom. nov. for *T. elegantula* auct., figured by May (Illustr. Index Tasm. Shells, 1923, Pl. v., f. 7).

The genus *Thraciopsis* was provided by Tate and May for Angas's *Alicia*, preoccupied, and they named *angustata* as type. Valves of the two species simultaneously described by Angas appear to be common on the Sydney beaches, but on closer investigation the species locally named as *elegantula* proved to differ appreciably from Angas's description and figure. Moreover, Stutchbury

had, many years previously, named from Port Jackson, *Anatina elongata* (Zool. Journ., Vol. v., p. 100, Suppl., Pl. xliii., f. 9-10), which has been neglected. The description and figure are poor, but show a shell not unlike Angas's *elegantula* in shape, but with a long pallial sinus whereas Angas's shell had a very short sinus; the shell wrongly identified as Angas's species has a very long sinus. By means of live specimens dredged at Twofold Bay, I have been able to identify Stutchbury's species, which may be placed in *Thraciopsis*. It may be recalled that Smith rejected the genus *Alicia*, placing the species in *Myodora*, and Tate described some fossils under this genus, comparing them to the species of *Alicia*, as *Myodora praelonga* (Trans. Roy. Soc. S. Aust., ix., 1886 (Mch., 1887), p. 174, Pl. xix., figs. 12a-d) from Muddy Creek, very like *angustata*, and *M. angustior* (ibid., p. 175, Pl. xvi., f. 16) from Muddy Creek, a rather different elongate species. May recently described *Myodora elongata* (Proc. Roy. Soc. Tasm., 1915, p. 98, Pl. 8, f. 40-40a), which I propose to add to the N.S.W. List (post), which he has transferred to *Thraciopsis* in his Check List (p. 13, No. 73) and which would clash with Stutchbury's species if left here, but it seems a *Myadora*. Gould's *Thracia cultrata* is certainly unrecognisable from the description, but has nothing to do with *angustata*, suggesting a shell more like *Periploma micans* Hedley, the dimensions being 8 mm. x 6 mm. x 4 mm., the words "alba, tenuissima, ventricosa intus argentata, apophysa cardinali triangulari" indicating a genus unlike *Thracia*. Hedley's *Thraciopsis arenosa* (No. 112), sometime referred to *Pholadomya*, cannot be included with *angustata*, and it will be best to provide a new generic name for it alone, viz., *Thracidora*, rather than bandy it about still further in unsuitable genera.

The species arranged under *Myodora* require subdivision, and the smooth species may be separated at once, but it is suggested that later the corrugated species will be investigated and re-defined. To take them in Hedley's order, I find confusion in No. 117. Verco's *Myodora corrugata* has been made a synonym of *albida* Ten.-Woods, and Gatliff and Gabriel have described as a new species, *subalbida*. Ten.-Woods's species had not been figured when I examined the species in England, but since May has given a figure of *albida* which does not agree with specimens from Verco of his *corrugata*, nor with specimens from 100 fathoms off Cape Pillar, Tasmania, named *albida* by May. Then, as from the last-named locality, May has figured one valve as *subalbida*, which is quite different from Gatliff and Gabriel's figure of the type. Unfortunately, Verco's name had been used by Tate (Trans. Roy. Soc. S. Aust., ix., 1886, p. 175, Pl. xvii., figs. 11a-b), for a very different Muddy Creek fossil. On Plate xxxiii., figs. 3-4, 13-14, I have given photographs of the two species, *albida* and *subalbida*, as I have determined them.

No. 122, *Myodora ovata* Reeve must be rejected. It was described from the Island of Zebu in the Philippine Islands, and Reeve wrote "This species exhibits a greater disparity in the sculpture of the valves than any other, the striae of the right valve being very fine and close set, whilst those on the left are almost keel-like and comparatively distant," and the figures agree. The shell known in Australia by Reeve's name disagrees entirely, having strong sculpture on both valves, the southern shells very bold, especially those from Victoria and South Australia, which recall the description of *Myodora corrugata* Tate (Trans. Roy. Soc. S. Aust., ix., 1886 (Mch., 1887), p. 176, Pl. xvii., figs. 11a-b) from Muddy Creek, but disagree in shape.

I am describing the so-called "*ovata*" as a new species, and am continuing the usage of the original spelling *Myadora*, as I see no reason for alteration.

The type of *Myadora* is the large species, *brevis* Sowerby, which has superficially a different appearance from the commoner species, but I have not yet found any separable structural character.

(122) MYADORA COMPLEXA, n.sp. (Plate xxxiii., figs. 9-10).

Shell of medium size for the genus, oblong-ovate, inaequilateral, fairly solid, anterior side rounded, longer than the posterior, which is straightly sloping and abruptly truncate. Right valve convex, left valve flat, clasped all round by the right valve.

The sculpture consists of bold concentric ridges, as well marked on the left as on the right valve where, however, they are more deeply incised; a microscopic radial sculpture overrides all the ribs, but is more easily seen on the flat valve; umbos acute, that of the right projecting over the left, a posterior area marked by a raised rib noticeable in the right, little elevated in the left, the sculpture being less pronounced towards the posterior truncation.

Type: length 26 mm.; depth 19 mm.; more rounded form, length 24 mm.; depth 19 mm. Well known under the incorrect name of *M. ovata* Reeve, common in the shallow water dredgings at Twofold Bay and very numerous in 10-15 fathoms in Disaster Bay.

(123 A) MYADORA ROYANA, n.sp. (Plate xxxiii., figs. 5-6).

Probably a deepwater relative of *M. pandoriformis* (Stutchbury) but of different shape and finer sculpture, while *M. australis* Johnston (Proc. Roy. Soc. Tasm., 1879 (1880), p. 40) from Table Cape, Tas., should be compared.

Shell inequivalve, almost equilateral but eccentric, thin, semi-ovate in shape. Right valve convex, left valve flat, clasped by right valve. In the right valve the apex is incurved, the posterior dorsal margin somewhat deeply concave, with a large truncation, the ventral margin convex, meeting the straight anterior dorsal margin at a rather acute rounded angle: the posterior area is marked by an obsolete ridge with the concentric sculpture, common to this genus, more marked than on the anterior area where they fade away towards the anterior end. This concentric sculpture consists of closely spaced ill-defined ridges, merging ventrally. The left valve corresponds in shape, but the sculpture is indefinite on the posterior area, which is faintly indicated and the ridges are more widely spaced and more noticeable towards the anterior end: a fine granular decussation (microscopic) overrides the sculpture on this valve. Length of type 17 mm.; depth 9 mm. In 50-70 fathoms off Green Cape, N.S.W.

(123 B) PHRAGMORISMA WATSONI (E. A. Smith, 1885).

Thracia watsoni E. A. Smith, Chall. Rep., Zool., Vol. xiii., 1885 (pref. 1 Oct.), p. 69, Pl. vi., figs. 5-5b: Station 162, East Moncoeur Island, Bass Straits. 38-40 fathoms.

When Smith described this shell, he wrote "This fine large species is remarkable on account of its flattened compressed character, and being almost equilateral. The ligament pit is very strong, and the outer epidermal shell layer is peculiar." This was intended in comparison with European Thraciae as the epidermal shell layer is very like that of the so-called Australian *Thracia*. A few years later Tate introduced the genus *Phragmorisma* (Journ. Roy. Soc. N.S.W., xxvii., 1893 (Mch., 1894), p. 189), giving as examples *Thracia watsoni*

Smith and *Phragmorisma anatinaeformis* nov., Pl. xii., fig. 1, an "Eocene" fossil from Spring Creek, near Geelong, and Table Cape, Tasmania, apparently naming the latter purely because it was the fossil representative of the recent shell. Three dead and broken valves, dredged in 15-25 fathoms, in Twofold Bay, add this interesting genus to the New South Wales List.

(145) CRASSATELLITES KINGICOLA (Lamarck, 1805).

The generic name *Crassatella* having, in its first introduction, simply a figure cited, which proves to be that of a *Mactra*, the name has been abandoned. The substitute utilised, *Crassatellites*, seems a bad one for our purpose, and I have already advised its rejection. In any case, the name can only apply to a fossil series which differ from the recent ones. I, therefore, propose ***Eucrassatella*** as a new generic name with *Crassatella kingicola* Lamarck (Ann. Mus. Hist. Nat. Paris, vi. (not v., as given by Hedley), Dec., 1905, p. 408) from King Island.

A fine series showing growth stages was forwarded by Roy Bell from the following places: about forty living specimens from 15-25 fathoms in Twofold Bay from sandy mud and soft mud; from 20 fathoms off Lennard's Island, 7 miles north of Eden from a fine sand bottom; and half a dozen from 15-20 fathoms in Disaster Bay from coarse sandy bottom. These show a little variation in shape, but constancy in coloration and sculpture: all the immature specimens are rounded, with short beaks, comparatively compressed, and with a pale brown epidermis. As they grow older, the beaks lengthen and the shell becomes more swollen, with the coloration becoming more blackish and wearing off at the umbos: they are, nevertheless, always a little compressed and the excavate lunule and escutcheon never deepen to any great extent. The sulcations at the umbos are always present, and number from twelve to sixteen before they fade away. The measurements of a growth series read: Altitude 27: longitude 33: depth of conjoined valves 15 mm.; then 38 x 46 x 22, 48 x 58 x 25, 55 x 62 x 30 and 57 x 65 x 30 respectively. Adults show variation in shape, as two dredged together give 65 x 75 x 30 against 60 x 82 x 35, while the largest of my series measures 72 x 90 x 42 mm. Verco has reviewed a series he dredged in South Australian waters, and those appear to range larger and be more swollen with slightly longer beaks and fewer sulcations umbonally. Although Verco stated "It is, therefore, least like *C. kingicola* Lam.," I think he intended "most like," and that his shells fairly represented the true form. Eastern Tasmanian shells are similar as regards sculpture, a little longer beaked than the Twofold Bay shells, smaller, more swollen and a little more solid.

Lamy (Journ. de Conch., lxii., No. 4, 15 Feb., 1917, p. 197, et seq.) has given a "Revision des Crassatellidae vivants du Muséum d'Histoire Naturelle de Paris," and has figured the type of *Crassatella kingicola* from King Island on Pl. vi., fig. 1, and I can exactly match the figure with some of my specimens. As Reeve, eighty years ago, had named many "species" which were not understood, in view of my own results I carefully criticised the British Museum collection. I found that all the shells coming from any given locality were comparatively constant and that errors of incorrect localisation could be at once detected. The attachment of the names required careful study, as some of the specimens described by Reeve were in the "Mus. Stainforth" which was dispersed, and nothing is at present known regarding the figured shells. Specimens named in the British Museum from the Cuming Collection may even be the missing shells, but, in any case, they are as authentic as can be got. Reeve's ***castanea, decipiens***, and ***pulchra*** were simultaneously described (Proc. Zool. Soc. Lond., Nov., 1842, pp. 42, 43),

from the "Coasts of New Holland," the two former being now localised as Swan River, the latter as coming from Port Essington and Kangaroo Island, the latter locality undoubtedly false. *C. errones* Reeve, a name sometimes met with, appears to be a clerical error for *decipiens*, the shell so labelled in the British Museum also being shown from Swan River. Ten years later A. Adams (Proc. Zool. Soc. Lond., 1852 (23 May, 1854), p. 90) published two more species, *Crassatella obesa*, Pl. 16, fig. 2 from "New Zealand, deep water, Mr. Strange," and *C. cumingii*, Pl. 16, fig. 1 from "Moreton Bay, deepwater, Mr. Strange." The former has not since been found in Neozelanic waters, and it may be an obese juvenile aberration of the Moreton Bay shell, and not have come from New Zealand.

The South-west Australian shells are smooth with sulcate umbos like the typical form, but are constantly more elongate with deeply excavate lunule and escutcheon. These should bear the name *castanea* Reeve. The North-west Australian specimens are paler in coloration, and deeply sulcate throughout, as well as elongate in form: these should be called *pulchra* Reeve. Lamarck proposed the name *C. sulcata* for a Paris fossil, with a living species collected by Peron in New Holland as a variety (Ann. Mus. d'Hist. Nat., vi., Dec., 1805, p. 408), but later (in the Hist. Anim. s. Verteb., Vol. v., July, 1818, p. 481) practically transferred the name to the living species, citing the fossil as the variety. This has misled many writers into using the Lamarckian name for the recent shell. Nyst (Bull. Acad. Roy. Soc. Belg., 1847) and Deshayes (Traité élem. Conch., Vol. ii., 1851, p. 113) indicated the incorrect usage, and renamed the recent form *lamarckii*. Lamy (Journ. de Conch., lxii.) has figured the type of *C. donacina* Lamarck (Ann. Mus. d'Hist. Nat. Paris, vi., Dec., 1805, p. 408), and finds it is labelled as from "Shark's Bay, West Australia": as specimens from "Shark's Bay, West Australia," also collected by Peron, prove to be the recent *sulcata*, it is obvious that some error has crept in, and that the type of *donacina* came from King Island, and that the Shark's Bay shells are sulcate, belonging to *pulchra*, though at the extremity of the range it may show some variation. A different shell lives at Torres Straits, ranging down to Port Curtis, these shells having short beaks and semi-sulcation and apparently a form of this runs down into northern New South Wales, while a close ally is shown in the Australian Museum from Lord Howe Island. The Moreton Bay shell was named *C. cumingii*, and this can be used until a long series is collected from the southern localities and contrasted with the Torres Straits ones. Hedley has used for this, Reeve's name of *corbuloides*, but the specimen in the British Museum accepted as the type, and agreeing with Reeve's figure (Pl. ii., f. 9) is an abnormality from unknown locality, and compared by Reeve himself with a South American species. As the species was described from the "Mus. Stainforth," the real type may be lost, and therefore unrecognisable exactly. The following is given as the nomination suggested as a basis for further work:—

Eucrassatella kingicola Lamarck, 1805. From Southern New South Wales, = *donacina* Lamarck, 1805. Tasmania, Victoria and South Australia.

Eucrassatella castanea Reeve, 1842 (South-west Australia) = *decipiens* Reeve, 1842, = *errones*, lapsus only.

Eucrassatella pulchra Reeve, 1842 (North-west Australia from Shark's Bay to Port Essington) = *sulcata* Lamk., 1818, not *sulcata* Lamk., 1805, = *lamarckii* Nyst, 1847 = *lamarckii* Deshayes, 1851.

Eucrassatella cumingii A. Adams, 1854 (Queensland and Northern New South Wales).

Eucrassatella obesa A. Adams, 1854, said to be from New Zealand but locality yet unconfirmed.

(145 A) Talabrica aurora (A. Adams and Angas, 1864).

Crassatella aurora A. Adams and Angas, Proc. Zool. Soc. Lond., 1863 (1 Apl., 1864), p. 426, Pl. xxxvii., f. 15: Banks Straits, Tasmania; *C. banksi* id., loc. cit., p. 427, Pl. xxxvii., f. 16: same locality.

Roy Bell dredged six specimens in 12-18 fathoms off Lennard's Isle, near Merimbula, seven miles north of Eden, Twofold Bay. Each is a different size, and they vary in shape, slightly in coloration and in coarseness of sculpture. From study of this series and the types in the British Museum, I conclude that Adams and Angas's two species are simply individual variants, but agree with Sir J. Verco that *C. carnea* Tate may be recognised as the distinct Adelaidean representative.

After much study of the large *kingicola*, it is difficult to accept this form as congeneric, notwithstanding the great authority of Dr. Dall (Trans. Wagner Free Inst. Science Phila., iii., pt. vi., Oct., 1903, p. 1464) who concluded "*Crassitina* Weinkauff 1881 was proposed for the smaller recent species, which resemble *Pachythaerus* except in the greater development of the resiliary pit. The type of the genus (*Crassatellites*) (*C. gibbosulus* Lamarck, according to Bronn) belongs to the type named by Conrad *Pachythaerus*, which is, therefore, an absolute synonym of *Crassatellites*. *Crassitina* (sic) Weinkauff is only the modern representative of *Pachythaerus*, and therefore falls into the same synonymy." It may just be observed that *Pachythaeras* Conrad was proposed for an American *Cretaceous* fossil, and the recent Austral forms differ too much to be considered congeneric, especially as Muddy Creek fossils vary appreciably from present-day shells.

With regard to the name *Crassatina*, above quoted, the details are of interest. In Kuster's continuation of the Conchylien Cabinet of Martini and Chemnitz, the monograph of *Crassatella* bears on the title page by "Löbbecke and Kobelt," 1886, without any indication that it had been begun by Weinkauff and that pp. 1-16, Pls. 1-6, had been published in Lief. 307 in 1881, and is recorded in the Zoological Record, and the name *Crassatina* there credited to Weinkauff. No species were named by Weinkauff and the group-name was later ignored by Löbbecke and Kobelt, but Dall (loc. cit., p. 1468) has named as type *C. contraria* (Gmelin) from Senegal, so we can leave it to that style of shell which is unlike ours.

Consequently, I propose *Talabrica* with *C. aurora* A. Adams and Angas as type. When Hedley discussed the "Thetis" mollusca, he noted the small species referred to *Crassatella* and queried *Crassatina* Weinkauff as being applicable. As above shown, it cannot refer at all, so I propose the new generic name *Salaputium* and name *Crassatella fulvida* Angas as type. This group is well developed in southern and eastern Australian seas, many species being already named, and new species being in collections, such as from the Kermadec Islands, Lord Howe and Norfolk Islands. No Australian collector, nor in all probability, any other student, would class these minutiae with the huge *Eucrassatella*, save by traditional assistance.

(156) Cardita calyculata (Linné, 1758).

Linné described his *Chama calyculata* from the Mediterranean Sea, and the local species is easily distinguishable. Fortunately, there are several names available. Lamarck described *Cardita aviculina* (Hist. Anim. sans Verteb., Vol. vi.,

July, 1819, p. 26) from Shark's Bay, Western Australia, and King Island. Naming the first as the type locality, the name may be used for the tropical form which resembles more closely the Mediterranean shell, so that Lamy regarded Lamarck's name as a synonym. Deshayes monographed the group, and he described *Cardita excavata* (Proc. Zool. Soc. Lond., 1852 (23 May, 1854), p. 100, Pl. xvii., figs. 1-3) from Sydney. Verco added as a synonym *Mytilicardia tasmanica* Ten.-Woods (Proc. Roy. Soc. Tasm., 1875 (1876), p. 161) from Blackman's Bay, south Tasmania, when he recorded the present species from South Australia as "Taken on the beach at Venus Bay, west coast of South Australia: very rarely dredged."

(157) VENERICARDIA AMABILIS (Deshayes, 1854).

In the Check List are included *V. amabilis* Deshayes and *V. beddomei* Smith as different species. Tate and May (and more recently May) allowed two species, *amabilis* Deshayes and *bimaculata* Deshayes, citing as synonyms of the latter *gunni* Deshayes and *atkinsoni* Ten.-Woods. Pritchard and Gatliff followed Tate and May, but Verco discussed the species, noting the variation, and recognising the same two, recorded as synonyms of the former, *beddomei* Smith and *gemmulifera* Tate. No one observed that *gunni* had place priority over *bimaculata*, being described from Tasmania, while the other was localised as New Zealand, as was *amabilis*, all being published at the same time. Suter doubtfully admitted *amabilis* to the New Zealand list, but did not mention *bimaculata*.

Study of the British Museum collection in conjunction with a fine lot of specimens sent by Roy Bell, dredged at various depths in Twofold Bay and Disaster Bay, the latter being very large and typical *beddomei*, proves that *beddomei* is absolutely a synonym of *amabilis*; that probably the Neozelanic locality was false, and that it ranges from northern New South Wales down the east coast to southern Tasmania, and to South Australia as *gemmulifera*, but which does not seem separable even as Verco concluded. The species *bimaculata* apparently does not occur in New Zealand, but is common in Tasmania and Victoria, and *atkinsoni* Ten.-Woods is accepted as synonymous. Examination of the type of *gunnii* in the British Museum showed that this species had nothing whatever to do with *bimaculata*, as it is a very small obese shell, most like *elegantula* Deshayes described from the China Seas. When Hedley described his *Cardita cavatica*, he observed "By its remarkable sculpture it is allied to a small group of Tertiary *Cardita*, typified by *C. gracilicostata*, Ten.-Woods, from which it differs by smaller size and greater length in proportion to height." I find this sculpture in the juvenile of *amabilis*, indicating the descent of *amabilis* from species not unlike *gracilicostata*, and that *cavatica* is related to *amabilis*, by keeping the ancestral style of sculpture in the deeper water.

(161) VENERICARDIA RAOULI (Angas, 1872). (Plate xxxiii., figs. 11-12).

This recently re-discovered species appears to be a regular constituent of the deeper water fauna, a large number being secured in from 50-70 fathoms off Green Cape, N.S.W. It is quite an abnormal species, recalling the shore-frequenting *Cardita* in form, so I propose the new genus *Bathycardita* and name *C. raouli* Angas as type. Dall, when he studied this group, concluded that form was of more significance than the variations of the hinge-teeth.

Young shells show hollow spines on the ribs while senile specimens tend to smoothness, in which state they somewhat resemble *Cardita astartoides* von Martens (Sitz. Gesellsch. Nat. Freunde Berlin, 1878, p. 25) from Antarctic Seas.

Hedley drew attention to Clessin's *Cardita racuti* Angas (Conch. Cab. (Küster), Bd. x., 1887, p. 11, Pl. 2, figs. 7-8) suggesting it was meant for *raouli*. This is certain, but the shell figured by Clessin was in the "Coll. Paetel" from "Neuseeland," and is *not* the present species. *Bathycardita raouli* (Angas) is a characteristic mollusc of the deeper water of southern New South Wales, being represented in nearly every haul over 50 fathoms. With it was associated the solitary coral, *Flabellum australe* Moseley (Chall. Rep., Zool., Vol. ii., 1881, p. 173, Pl. vii., figs. 4, 4a, 5, 5a, 5b), which was described from Station 163, off Twofold Bay, 120 fathoms.

(173) LUCINA INDUTA Hedley, 1907.

This deep-water form was not dredged by Bell, and is here noted simply for the purpose of amending the name. *Lucina* has lost its traditional usage, and is now restricted to an American type, nothing like the present quaint little species. Hedley's good figures and description are sufficient for every purpose, so I simply propose the new generic name *Mendicula*, and rename the sole species, *Mendicula memorata*, as *Lucina induta* had been previously used by Stoliczka (Martens, Journ. Linn. Soc. Lond., Zool. xxi., 1887, p. 174).

(177) MYRTAEA BOTANICA Hedley, 1918.

Valves were dredged in 50-70 fathoms off Green Cape, N.S.W., and these agreed with the figures and descriptions of *Lucina mayi* Gatliff and Gabriel (Proc. Roy. Soc. Vict., xxiv., n.s., Sept., 1911, p. 189, Pl. xlvii., f. 8-12), who described their species from Port Phillip, Victoria, 5 F., noting that it differed from *Lucina brazieri* in the possession of radial sculpture and much sharper sculpture. Hedley, accepting this difference, when he transferred Sowerby's twice-named *Tellina brazieri* to *Myrtaea*, renamed the Sydney shell *Myrtaea botanica*. The Sydney species, however, possesses radial sculpture and differs only in its larger size. Consequently, Hedley's name would become subspecific only. Hedley has also named *Myrtaea bractea* (Zool. Res. Endeavour, pt. i., 22 Dec., 1911, p. 99, Pl. xvii., figs. 5, 6, 7, 8) from 100 fathoms south of Cape Wiles, S. Aust., which does lack radial sculpture, and is quite distinct. For this group I propose *Notomyrtea*, naming *M. botanica* Hedley as type, the excellent figures and descriptions already published enabling easy recognition.

(180) DIPLODONTA ADAMSI (Angas, 1868).

For this species, described by Angas under the genus *Mysia*, subgenus *Felania*, I propose the new generic name *Numella*. This genus appears to be close to *Felaniella* Dall (Journ. Conch., ix., 1899, pp. 244-245), proposed for a Japanese species *Felania usta* Gould.

The two Australian species, *adamsi* and *jacksoniensis*, both of Angas, published at the same time, differ a little from each other in their hinge-teeth, but they may, for the present, be classed together. I could not understand how this species had been placed under *Diplodonta*, and left there so many years, until I found that it was one of the commonest shells of the Sydney beaches, being even used to make ornaments by the aborigines of Botany Bay, and thus, on account of its very commonness, had escaped serious study.

When Tate met with a fossil, he named it *Sacchia* (sic) *suborbicularis* (Trans. Roy. Soc. S. Aust., 1886, p. 147, Pl. xviii., fig. 10a-c) comparing it with these shells, but noting the hinge so unlike that of *Diplodonta*, and evidently not examining the hinges of these two species.

(187) ERYCINA ACUPUNCTA Hedley, 1902.

When Lamarck introduced the genus *Erycina* (Ann. Mus. Hist. Nat. Paris, vi., Dec., 1805, p. 413) he stated "On ne connoit encore que des espèces fossiles," and described six fossils as *E. laevis, pellucida, trigona, inaequilatera, fragilis,* and *elliptica*. In the next volume (p. 53) he continued with *E. undulata, pellucida* (again), *obscura, miliaria* and *radiolata*.

In Hist. Anim. s. Verteb., Vol. v., 1819, p. 485, he added, as a recent species, *E. cardioides* from King George Sound, Australia, and this species has been cited as the type by some writers, e.g., Chenu. By technical manipulation, the generic name has recently been revived in connection with a fossil group, but its nomenclatorial status is very uncertain, and certainly the name *Erycina* should not be used in connection with Australian recent mollusca. I, therefore, propose the new genus *Melliteryx*, naming Hedley's species, *acupuncta*, as type.

(190) BORNIA LEPIDA Hedley, 1906.

The reference to *Bornia* is obviously due to Dall's conclusions, as admitted by Hedley in connection with the species he next dealt with (*Rochefortia donaciformis* Angas). The name *Bornia* is of such uncertain status, even in connection with European bivalves, that it would be unwise to continue its usage here. The species Hedley has named from New South Wales are very interesting, and Born's name may be retained in connection with Austral molluscs by proposing the new genus *Borniola*, and citing the commonest species, *B. lepida* Hedley, as type.

(198) ROCHEFORTIA ANOMALA (Angas, 1877).

This is a case where a name change can be welcomed. When Dall dismissed the generic name *Tellimya*, he selected *Mysella* Angas as the best substitute: a little later he recognised *Rochefortia* as congeneric, and on the score of priority gave it precedence. This usage was accepted by Hedley, but Dall had erred, and *Mysella* has priority. We are, therefore, at liberty to use an Australian name for Australian shells, without discussing the relationship of the foreigner.

Mysella Angas, Proc. Zool. Soc. Lond., 1877 (1 Aug.), p. 176; Type by monotypy *M. anomala*, id., Pl. xxvi., f. 22. P. J.

Rochefortia Velain, Compt. Rendus Acad. Sci. Paris, lxxxiii., 1876, p. 285, nom. nud.; Archiv Zool. Exper., vi., 1877 (1878), p. 132.

Velain's paper was read on 11 April, 1877, and passed for printing by the examiners on 12 Nov., 1877, only, and the title page reads 1878.

(217) CARDIUM PULCHELLUM Gray, 1843.

Hedley, dealing with the "*Thetis*" collection, proposed *Cardium striatulum* Sowerby var. *thetidis*, nov. (Mem. Austr. Mus., iv., part 5, 29 July, 1902, p. 322), writing "A considerable series taken by the "*Thetis*" appears specifically inseparable from *C. striatulum*," but gave differential features to justify a varietal name. I have compared the whole of the material in the British Museum with a large number of specimens and valves secured by Roy Bell in various depths, and find Hedley's characters are quite constant, and I accept their value as specific. The difference between this style of shell and typical *Cardium* is very great, and I, therefore, propose the new genus *Pratulum*, naming *Cardium thetidis* Hedley as type.

(221) DOSINIA CROCEA Deshayes, 1853.

When Hedley examined in the British Museum collection of shells, the specimens, named as different species, in this genus, he observed that his conclusions must be revised. I received a large number of specimens and carefully criticised the British Museum series in connection with them, and arrived at certain results. More recently Mr. J. R. Le B. Tomlin, arranging some bivalves in the British Museum, studied this genus and, after he had completed his work, we both went over the whole lot and agreed upon every point. As our results were quite independently achieved, they may be regarded as fairly representing the truth.

Thus, we concluded that Deshayes *crocea* and *circinaria* were synonymous, and that the former name should be maintained on account of place priority.

(224 A) DOSINIA VICTORIAE Gatliff and Gabriel, 1914.

Dosinia victoriae Gatliff and Gabriel, Proc. Roy. Soc. Vict., xxvii., Sept., 1914, p. 96, Pl. xvi., figs. 17-19: Western Port, 5-10 F.

Before this species was described, Mr. Gabriel sent it to me for comparison with the British Museum series; a shell sent by Bell from Twofold Bay, was found to differ from all the others, and regarded as new, until I remembered Gabriel's inquiry, when I found this shell was their new species, an addition to the N.S.W. List.

(224 B) DOSINIA CAERULEA Reeve, 1850.

Artemis caerulea Reeve, Conch. Icon., vi., Artemis, Feb., 1850, Pl. iv., sp. and fig. 25: Raine Island, Torres Straits, Captain Ince: Mus. Brit., i.e., error for Tasmania.

This species was found commonly washed up at Twofold Bay, N.S.W., but was not dredged, except as young, whereas, in Disaster Bay, it was dredged in 10-20 fathoms. This is a fine addition to the N.S.W. List.

(225) SUNETTA TRUNCATA (Reeve, 1864).

When Reeve figured this species he gave a reference to Deshayes, and I find that Deshayes had described a *Cuneus truncatus* (Cat. Conch. Biv. B.M., 1853, p. 43), from the Philippine Islands in Mus. Cuming. In his selection, Deshayes had been anticipated by Costa (Brit. Conch., 1778, p. 205), so that we are relieved of the consideration of Deshayes's specific name.

For the Port Jackson species, Angas had proposed the name *Sunetta adelinae* (Proc. Zool. Soc. Lond., 1867 (Apr., 1868), p. 909, Pl. 54, f. 5) and therefore no new name is required.

From Lakes' Entrance, Victoria, Roy Bell sent a number of valves of the species listed by Pritchard and Gatliff as *Sunetta excavata*, citing as basis, *Cytherea excavata* Hanley (Proc. Zool. Soc. Lond., 1842 (Jan., 1843), p. 123), described from unknown locality in the Museum Stainforth. The name has been commonly used for a Japanese species, but again, fortunately, discussion is unnecessary as there is a prior *Cytherea excavata* Morton (Synops. Org. Rem. Cret. Group U.S., 1834, p. 67). Two names are available for the southern Australian species, viz., *Cytherea vaginalis* Menke (Moll. Nov. Holl. Spec., 1843, p. 42) given to a Western Australian species, and *Sunetta aliciae* Adams and Angas (Proc. Zool. Soc. Lond., 1863, p. 425, Pl. 37, fig. 18) from Encounter Bay, S. Aust. According to the specimens in the British Museum these differed, and I propose

the use of Adams and Angas's name for the Victorian shell, and revive Menke's name for the Western Australian species listed by Hedley as *S. excavata* (Hanley). I find these are also separated as distinct in the Australian Museum.

Dall (Trans. Wagner Free Inst. Philad., iii., pt. v., Oct., 1903, p. 1245), admitted three groups of *Sunetta*, *Sunetta* s. str., type *Donax scripta* Linné; *Solanderina* Dall, 1902, type (o.d.) *S. solandri* Gray; and *Sunettina* Jousseaume (Le Naturaliste, Yr. 13, No. 108, 2 Ser., 1 Sept., 1891, p. 208), type, by tautonymy *S. sunettina* Jouss. The Australian species here noted fall into the last group, which should be used generically. *S. gibberula* Tate is a Muddy Creek fossil, ancestrally very closely related to the living *S. aliciae* Ad. and Ang.

(226) LIOCONCHA ANGASI (Smith, 1885).

Smith proposed *Circe angasi* as a new name for the shell named *Gouldia australis* by Angas (Proc. Zool. Soc. Lond., 1865, p. 459), when he transferred it to *Circe*, as the combination *Circe australis* was invalidated by the earlier *C. australis* Sowerby (Thes. Conch., Vol. ii., 1851, p. 651). When Hedley retransferred Angas's species to *Lioconcha*, he should have revived Angas's specific name. I cannot class it even in *Lioconcha*, so propose the new genus *Gouldiopa*, naming *Gouldia australis* Angas as type. When Smith named the species (Zool. Res. Challenger, Vol. xiii., 1885, p. 148, Pl. ii., figs. 4-4e), he gave a detailed description of the hinge-characters, and also figures, so that these are well known. I might point out, however, that the description is more accurate than the figures.

(227) GAFRARIUM QUOYI (Hanley, 1844).

When Dall reinstated *Gafrarium*, ex Bolten, he made two attempts to fix a type by elimination, and as it is doubtful whether either result is valid, the name may be dismissed from the Australian List. This is easier, since at the latter conclusion and place (Trans. Wagner Free Inst. Science Philad., iii., pt. vi., 1903, p. 1246), which Hedley has followed, he allowed *Circe* Schumacher (Essai Nouv. Syst. Test., 1817, p. 152), with type *Venus scripta* L., subgeneric rank. As Dall's subgenera are all available under present views as of full generic rank, and as the shell above named was previously called *scripta*, it will be admitted that *Circe* seems a very excellent alternative.

(227 A) FLUCTIGER ROYANUS, n. gen. et sp. (Plate xxxiii., figs. 7-8).

This is apparently the species recorded from Victoria by Gatliff and Gabriel as *Gafrarium navigatum* Hedley. The latter was described from the Capricorn Group, Queensland (These Proc., xxxi., 19 Nov., 1906, p. 476, Pl. xxxviii., fig. 33), and my shells were immediately recognised as congeneric from the figure. Comparison, in the British Museum, with valves sent by Hedley, proved them to differ in shape much more than the drawing would suggest. The general description given by Hedley applies to the sculpture and form, but the ventral margin in the southern form is less circular, and the altitude a shade less, and consequently the "waves" fewer in number, becoming obsolete towards the margin. It may be that the southern form is also larger, as Hedley's measurements are 6 x 5.4 mm., whereas mine are 9 x 8 and 11 x 9 mm. Both are dead valves, a right and a left, and are worn; they show the muscle impressions, but not the hinge-characters completely. As Hedley's species should be absolutely congeneric, and he dredged it alive, these may be recorded from that. When Smith (the only English writer (save Jukes Browne) who has studied bivalves) wrote

up the Challenger Report, he lumped in a most aggravating manner and ranged all these under *Circe* (*Gafrarium* of to-day), and his conclusions have not been since reviewed. On Pl. ii., figs. 4, 4e, he gave figures of the hinge, etc., of *Circe angasi*, and this does not agree with what I can make out of the hinge of the present form, which agrees better with that of *Circe*.

(228) MACROCALLISTA DISRUPTA (Sowerby, 1853).

This species, with the next, *M. kingii* (Gray, 1826), was dredged in numbers in 10-20 fathoms, in and outside Twofold Bay, and variation in size and shape was noted. Further Tasmanian shells named *disrupta* varied a little further, while Sydney shells referred to this species should have a distinctive name. Dall proposed to use the above generic name, given to an American fossil, to replace *Callista*, a Polian name previously in use. The southern species vary *inter se*, and I propose to eliminate *Macrocallista* from the Austral list, proposing *Notocallista*, naming *C. kingii* Gray as type.

Tate (Trans. Roy. Soc. S. Aust., ix., 1886 (Mar., 1887), p. 161, Pl. xviii., figs. 6-8) named *Cytherea submultistriata* from the Upper beds at Muddy Creek, comparing it with *C. disrupta*, and it certainly seems a closely allied ancestral form, only, in my views, trinomially separable.

As synonyms of *M. kingii* Gray, I noted in the British Museum, *inflata* Sow. and *rutila* Sow., but remarked that *lamarckii* appeared more elongate, and I had a very large series for comparison.

(230) PITARIA SOPHIAE (Angas, 1877).

Hedley has used the emendation *Pitaria*, but the name was proposed as *Pitar*, and I am advised that this is of classical form, although Dall did not recognise this.

From his (Dall's) discussion (Trans. Wagner Free Inst. Science Philad., iii., pt. vi., 1903, p. 1264), it is obvious that the recognition of the genus *Pitar* is a difficult task, especially as he has regarded *Venus dione* Linné as subordinate, with subgeneric value. In the British Museum this species was placed alongside the two previous species, while *Pitar* was also recognised. For the present then *Pitaria* may be dismissed from the Austral List, and this species ranged under *Notocallista*.

(238) ANTIGONA STRIATISSIMA Sowerby, 1853.

Venus striatissima Sowerby was apparently proposed as a new name for *Erycina cardioides* Lamarck (Hist. Anim. s. Vert., Vol. v., July, 1818, p. 486) from King George Sound, W. Aust., on account of another *Venus cardioides*. When the species was removed from *Venus*, the earlier name should have been reverted to. It is quite unlike the typical *Antigona*, and I, therefore, propose for it the new generic name *Chioneryx*. As Angas noted, the species recalls superficially the British *Venus ovata* Pennant, which is the type of *Timoclea* Brown, but the hinge-characters differ.

Erycina, as already shown, was introduced for a series of fossils, and afterwards the present species was added as a recent representative, being then cited by some writers, e.g., Chenu, as type of *Erycina*.

(247) MARCIA NITIDA (Quoy and Gaimard, 1835).

Quoy and Gaimard described *Venus nitida* from Hobart, Tasmania, and the name proves to be preoccupied by Defrance (Dict. Sci. Nat. (Levrault), Vol.

lvii., 1828, p. 290. As synonyms may be noted: *Venus fumigata* Sowerby, Thes. Conch., Vol. ii., 1853, p. 737, Pl. clix., figs. 152-5: Australia (Strange).—*V. laevigata* Sow., ibid., p. 738, Pl. clix., figs. 156-8: Australia (Strange).—*V. polita* Sow., ibid., p. 738, Pl. clviii., figs. 139-40: given to Quoy and Gaimard's figure alone, therefore refers to Hobart, Tasmania.—*Tapes faba* Reeve, Conch. Icon., Vol. xiv., Feb., 1864, *Tapes* sp. 39, f. 39, Pl. viii.: Hab — ? Mus. Cuming.

The specimens collected by Strange probably came from Sydney Harbour, and the figures agree very well with local shells. If southern Tasmanian shells differ, as they appear to do, they may bear Sowerby's third name.

The genus name *Marcia* was used by Hedley for this species and *scalarina* Lamarck, an association that seems strained, in view of the differential characters used in this family. *Marcia* proves to have been used previously by Warlow (Journ. Asiatic Soc. Bengal, ii., 1833, p. 100), and there is a generic name *Katelysia* Römer (Krit. Unters., May, 1857, p. 17), available for *scalarina* Lamk., that species having been definitely named as type by Dall, which should be used.

Dall proposed (Trans. Free Inst. Science Philad., iii., pt. vi., 1903, p. 1289), *Macridiscus*, naming *Venus aequilatera* Sowerby, from Japan as type, observing "*Venus faba* Reeve and *V. fumigata* Sowerby seem to belong to this section" (of the subgenus *Gomphina*, genus *Chione*). Our shell does not seem to have a close relationship, disagreeing even with Dall's definition. I, therefore, propose the new name *Eumarcia*, naming *Venus fumigata* Sowerby as type.

(243) Bassina paucilamellata (Dunker, 1858).

Hedley has recently shown that the specific name must be *pachyphylla* Jonas, 1839, and a note on its station may be here intercalated, as, though Bell did not get this at Twofold Bay, he found a few valves at Port Fairy, Vic. I found it commonly on the beach at Port Fairy, Vic., and Hedley found it commonly at Twofold Bay, in each case in the early spring. Roy Bell never dredged it, which proves that it lives just below low water, not going even into 5 fathoms. Consequently, it is variable in shape, and the two fossils Tate described (Trans. Roy. Soc. S. Aust., ix., 1886 (Mar., 1887), p. 159, Pl. xiv., f. 14 and p. 160, Pl. xiv., f. 18) under the names *Cytherea paucirugata* and *C. murrayana* respectively, are obviously ancestral and scarcely separable save by the nomination I have suggested, a trinomial one indicating the ancestral form without prejudice to the specific status. Thus *Cytherea* [*victoriae*] *paucirugata* would have explained everything in one phrase at the time of description.

(262) Tellina inaequivalvis Sowerby, 1867.

In selecting a Linnean name, Sowerby lost his specific right, and I here propose the new name *Tellina beryllina* for Sowerby's shell, the type of which is in the British Museum.

The grouping of *Tellinid* species must be undertaken at the first opportunity, as in the British Museum they are arranged in the most haphazard fashion, the same species occurring under two different groups, even of family rank. Error has accumulated upon error, until it is difficult to determine any definite data.

Thus No. 272 is named *Arcopagia striatula* Lamarck, 1818, but Lamarck's *Tellina striatula* was based on "List Conch., t. 267, f. 103," with the locality "L'Ocean d'Europe," and Lister had no Australian shells. It is fortunate that Olivi (Zool. Adriat., 1792, p. 101) had previously used the name, and so settled the discussion.

(263) TELLINA SEMITORTA Sowerby, 1867.

An interesting abnormal little Tellinoid was un-named from the British Museum Collection. In the Australian Museum Collection it was found under the above name, and specimens had been identified by comparison with British Museum specimens. Some error has crept in as, though Sowerby described and figured his species from the Mus. Angas from Port Jackson, and while one figure suggests the shell here dealt with, the description was probably drawn up from a variant of *T. tenuilirata*, named and handled at the same time. The words "half twisted," "flexuous posteriorly," "end rather acuminated" do *not* apply to the specimens under review, which I determine as *Tellina subdiluta* Tate (Trans. Roy. Soc. S. Aust., ix., 1885-6 (Mar.. 1887), p. 65, Pl. iv., f. 9): Encounter Bay, S. Aust., 22 F.

(264) TELLINA TENUILIRATA Sowerby, 1867.

This beautiful little species was common in the shallow water dredgings in Twofold Bay and district, and it was obvious that it was not a normal *Tellina*. Upon investigation I found that E. A. Smith, in the Challenger Reports, had given details of the hinge-teeth, and suggested the differentiation of the species, but did not name it, generically. In the British Museum, so that there should be no difficulty in finding this peculiar species, the specimens were separated, some being placed under the section *Angulus*, of the genus *Tellina*, while others were found under the genus *Semele*, in a different family. I, therefore, propose the new genus *Semelangulus*, with this species as type, so that it may be as easily traced in literature.

Tellina masoni Tate (Trans. Roy. Soc. S. Aust., ix., 1886 (1887), p. 166, Pl. xvi., fig. 6a-b) from Muddy Creek is very like this, from description and figure, and should be compared with it as Tate does not mention the present species.

(277) ABRA ELLIPTICA (Sowerby, 1867).

Sowerby named his species *Tellina elliptica*, but this name had been previously used by Brocchi (Conch. foss. Subapp., 1814, p. 513), and Lamarck (Hist. Anim. s. Verteb., Vol. v., 1818, p. 524). The species was described from Sydney in Angas's collection, and *Abra* is another of the Palaearctic bivalve generic names that is under discussion, and, therefore, not available for an Austral group. The only way to deal scientifically with the matter is the proposition of a new generic name for this species, *Abranda*, and renaming the species *Abranda rex*.

Superficially, this species appears to have fossil representatives, but the hinge-characters need careful study before associating species of complex history like this one.

(281) GARI LIVIDA (Lamarck, 1818).

Lamarck's *Psammobia livida* was localised as from Shark's Bay, W. Aust., and Dautzenberg et Fischer (Journ. de Conch., lxi., pt. 2, 1914, p. 224) have figured the types (Pl. vii., figs. 4, 5, 6). These figures suggest that two different species were confused, the figures 4, 5, referring to the species known as *P. modesta* Deshayes (*post*), while fig. 6 is in agreement with Lamarck's description, and represents the species previously known as *zonalis*. Smith (Chall. Rep., Zool. Vol. xiii., 1885, p. 95) separated *zonalis* and *modesta*, and gave a synonymy, drawn up from the British Museum specimens, which requires revision. From Dautzenberg and Fischer's notes, it is evident that they used Tasmanian speci-

mens for their recognition of *livida*, and it is here suggested that the Shark's Bay locality may be erroneous, and that the specimens came from southern Tasmania, where May states it is very common. Twofold Bay shells agree with such Tasmanian shells, but the northern shells, such as commonly occur on the Sydney beaches, differ in shape, tenuity, and size.

Deshayes described *Psammobia menkeana* (Proc. Zool. Soc. Lond., 1854 (8 May, 1855), p. 319) from Moreton Bay, and this was figured by Reeve (Conch. Icon., Vol. x., (Jan., 1857), sp. and f. 43, Pl. vi.) under the same name, from the type specimen, but without reference to Deshayes. This shell is more elongate with less height, and smaller and thinner than the Tasmanian *livida*, and is certainly not synonymous with *modesta* as given by Smith, but refers to the Sydney shell hitherto called *zonalis* = *livida*.

This would mean the acceptance of *Gari livida* (Lamarck, 1818) for the southern New South Wales species, and the recognition of *Gari menkeana* Deshayes for the northern and central New South Wales form, the exact value of the differences being at present unknown.

(291 A) Solen vaginoides Lamarck, 1818.

Solen vaginoides Lamarck, Hist. Anim. s. Verteb., Vol. v., 1818, p. 451: D'Entrecasteaux Channel, S. Tasmania.

Many small specimens received from Twofold Bay and Disaster Bay are referable to this species, which is an addition to the N.S.W. List. Hedley has recorded *Solen aspersus* Dunker as a synonym, and *Solen philippianus* Dunker (Proc. Zool. Soc. Lond., 1861 (7 Apr., 1862), p. 420) may also be added, though E. A. Smith (Proc. Zool. Soc. Lond., 1906, p. 857) regarded it as a MS name, citing it from Sowerby (Thes. Conch., 1874). While the facts in connection with this species seem fairly clear, it is otherwise with regard to the species already on the N.S.W. List, No. 291, *Solen sloanii* Hanley. This was described and figured (Illus. and Descr. Cat. Rec. Bivalve Shells, 1842, p. 12, Pl. xi., f. 18) from a British Museum specimen, so named in MS. by Gray. The tablet bears upon it the information "Mus. Sloane," hence the specific title, but no locality was known, and it obviously did not come from New South Wales, as the Sloane Collection was completed before any shells were collected in New South Wales. Other specimens I noted as marked Mus. Sloane are *Turritella exoleta* and *Monodonta labio*. Yet, when the History of the Collections in the British Museum (Natural History) was published in 1906, it was stated (Vol. ii., p. 704) "1759. Probably a number of shells were received with the collections bequeathed by Sir Hans Sloane (1759) and these would in all probability form the nucleus of the Museum Collection. It must be stated, however, that no record of any such specimens has been traced." The truth was, that no attempt was made to trace such specimens, as the shells themselves are, and have been, openly on view for the past forty years. Moreover, the year of the bequest is wrongly stated, being 1753, and there is on record the number of Shells, Echini, etc., this being 5845. To return to *Solen sloanii*, E. A. Smith recorded it (Proc. Zool. Soc. Lond., 1906, p. 857) from Zanzibar, and this is a more likely locality. I name the Sydney species, figured by Hedley (These Proc., xxiv., 1899, p. 432, fig. 3 in text), where the animal was described, *Solen correctus*, the shell being very like that of *S. vaginoides*, but straight. Tate has described a fossil from Muddy Creek as *Solen sordidus* (Trans. Roy. Soc. S. Aust., ix., 1886 (Mar., 1887), p. 181, Pl. xix., fig. 2).

(311 B) SAXICAVA SUBALATA Gatliff and Gabriel, 1910.

Saxicava subalata Gatliff and Gabriel, Proc. Roy. Soc. Vict., xxiii. (n.s.), Aug., 1910, p. 85, Pl. xix., f. 10-12: Port Phillip, Victoria, 8 fathoms.

Valves of this species were found in the shallow water dredgings from Twofold Bay, N.S.W., but it has no close relationship with *Saxicava*, the sculpture suggesting the *Eximiothracia-Phragmorisma* series.

(319) NAUSITORIA SAULII Wright, 1866.

Calman, working on Marine Wood-Boring Animals (Proc. Zool. Soc. Lond., 1920, p. 397) named *Xylotrya australis*, n.sp., text-figs. 6, 7, 8, from Brisbane, Q'land, and Auckland, N.Z., figuring only the syntype from Auckland. This was the species known under the above name, apparently incorrectly, as, though Wright stated that the type specimens in the British Museum came from Port Phillip, Australia, they are labelled "Callao, Peru," and do not agree with the Australian species.

Xylotrya proves to be a synonym of *Xylophaga*, and the generic name to be used is *Bankia*. This name was first introduced by Gray (Synopsis Contents Brit. Mus., 1840, p. 150) as a *nomen nudum;* and then in 1842 (p. 76) in the same publication, Gray defined it: "In *Bankia* they (the pallets of *Teredo*) are elongated, and formed of small cones one within the other, looking somewhat like a quill."

(342-372) Class *AMPHINEURA*.

As this class was Roy Bell's objective, though dealt with fully elsewhere, a few notes must here be included, as the collection provided unexpected data in connection with the zoogeographical regions. May and I had separated the eastern Tasmanian Coast as showing a distinct Loricate faunula from that of the mainland eastern coast, with which it had been previously united. To test this, the present collections were made, and the separation has been emphasised. Thus the most characteristic Peronian Loricates, *Sypharochiton pellis-serpentis* Q. and G., *Liolophura gaimardi* Blainville, and *Onithochiton quercinus* Gould, disappear before they reach Twofold Bay. *Rhyssoplax jugosa* Gould continues down to Mallacoota, Victoria, but is replaced in Western Victoria (Port Fairy) by the Tasmanian species, *Rhyssoplax diaphora* Ire. and May. The Tasmanian *Sypharochiton* (*maugeanus* Ire. and May) does not cross the Straits while two other Tasmanian species described at the same time, *Heterozona subviridis* Ire. and May, and *Ischnochiton atkinsoni* Ire. and May, proved to be the commonest species at Port Fairy, Vic., but not at Mallacoota, Vic. May and Hull found these at King Island, but May did not find them on the Flinders Group. This line of inquiry is being followed up. No Adelaidean form has reached Mallacoota or Twofold Bay, but the Peronian *Haploplax lentiginosa* Sow. was found commonly as far as Lakes Entrance, Victoria. The dredgings show some interesting items as from 18-25 fathoms in Disaster Bay and, later, in the same depths in Twofold Bay, a form of *Ischnochiton tateanus* Bednall was dredged, in the former case accompanied by a single *Is. purus* Sykes. Odd valves representing *Callochiton mayi* Torr. and *Callistochiton mawlei* Ire. and May were found in dredgings from 5-20 fathoms at Port Fairy, Vic., and out of the shallow water Twofold Bay dredgings valves apparently referable to *Rhyssoplax coxi* Pils., *R. carnosa* Angas, *Loricella angasi* H. Adams, and *Notoplax speciosa* H. Ad. were sorted. *Heterozona fruticosa* Pilsbry was also found at Mallacoota, as expected, with the Peronian *Callistochiton antiquus* Reeve, *Ischnochiton crispus* Reeve and intermediate forms of *Ischnoradsia* and *Ischnochiton proteus* Reeve.

(373-375) Family PLEUROTOMARIIDAE.

This should be replaced by the family name *Scissurellidae,* as there is little real relationship between the present minute species and the huge recent descendants of the fossil *Pleurotomaria.* Moreover, there are two different genetic series present in these small shells, the true *Schizotrochus* (e.g., *Scissurella australis* Hedley) being quite irreconcilable with the *Scissurella-Schismope* series. Thus the type of *Scissurella* is exactly comparable with the immature stages of such a shell as *Schismope beddomei* Petterd, and absolutely represents an arrested stage in the development of *Schismope.* The carinate *Schismope,* as *S. atkinsoni* Ten.-Woods, are closely allied to the typical series, whereas such a form as *Scissurella rosea* Hedley is distinctly separable. The *Schizotrochus* series seems to have no close relationship with the true *Scissurella,* and is apparently a world-wide form in deeper water.

(373 A) Scissurella ornata May, 1908.

Scissurella ornata May, Papers Proc. Roy. Soc. Tasm., 1908, p. 57, Pl. vi., figs. 4-5: Frederick Henry Bay, Tasmania.

The recognition of a single specimen of a true *Scissurella* suggested this species, and it generally agreed, allowing for the variation commonly noted in this group.

By this means *Scissurella* remains a constituent of the N.S.W. fauna, as *S. australis* Hedley belongs to the *Schizotrochus* series, a very different group.

I was going to omit this record for the present, when I found, in shell sand from Coogee, and also from Watson's Bay (Green Point), specimens of a true *Scissurella* along with specimens of an undescribed *Schismope,* allied to *brevis* Hedley, and many other minutiae, so that probably these things are well distributed, but have been merely overlooked owing to their minute size.

(375 A) Scissurella rosea Hedley.

This species was described from New Zealand, and was afterward recorded from Tasmania by Hedley, who rejected the name *obliqua* used for it by Pritchard and Gatliff and Verco, as that had been given to a different species from Kerguelen Island. I first recognised this form in shell-sand from South Australia sent me by Dr. Torr: I then sorted it out of some splendid shell-sand Roy Bell secured at Port Fairy, Vic., and, later, I found it in the shallow water dredgings from Twofold Bay, N.S.W. All the specimens differ from typical Neozelanic shells in shape, the Australian shells being more ear-shaped, the last whorl longer, the earlier whorls larger, the mouth not so patulate, and, consequently, the slit apparently higher up. As a matter of fact, the Australian shell is more like the shape of *Incisura lytteltonensis* Smith, from which Hedley easily distinguished the Neozelanic shell. There is no close relationship between this species and the true *Scissurella,* and when Thiele monographed the family, he placed it in *Incisura,* with which it is certainly not congeneric. I, therefore, propose the new generic name *Scissurona* and name *Scissurella rosea* Hedley as type, and propose *Scissurona rosea remota,* n. subsp., for the Australian form, selecting a Twofold Bay specimen as type. I do this, as more critical examination, with longer series and better material, may also prove the necessity of separating the Adelaidean form.

The extreme localisation of Hedley's *Incisura* is worthy of remark, as, though I have examined much shell-sand and dredgings, I have not met with that genus outside Neozelanic waters, while it appears in nearly every Neozelanic sample

examined. In the case of *Scissurona*, I think *obliqua* from Kerguelen Island will be found to belong here, although decidedly not conspecific with the Australian or Neozelanic species.

(376) SCUTUS ANTIPODES Montfort, 1810.

Hedley has recently developed this genus and separated the well-known Western Australian species under the new name *Scutus astrolabeus*. The Twofold Bay shells were typically Peronian, but the Port Fairy (Victoria) series were somewhat intermediate, being notably broader than the Peronian shells, but just as obviously narrower than the typical King George Sound species. A fine series was sent from Port Fairy, and the measurements of adult shells, ten large ones being selected, varied from 99 mm. x 47 mm. to 84 mm. x 40 mm., the average being 91 mm. x 43 mm.; the height varied from 14 mm. to 18 mm., while the apex was from 22 to 24 mm. from the edge. Juvenile shells, well grown, varied from 45 mm. x 21 mm. to 74 mm. x 32 mm., the height of the last-named being 8 mm., and the apex situated at 17 mm. from the edge. I showed Mr. Hedley the figure of *Patella anatina* Donovan (Rees Encyclop. Conch., 1 Oct., 1813, Pl. xvi.), and he at once suggested it might be the Western Australian species. The figure, which appears life size, measures 79 mm. x 38 mm., with the apex 16 mm. from the edge.

(378) HEMITOMA ASPERA (Gould, 1846).

When Hedley rejected *rugosa* Quoy and Gaimard for the New South Wales shell on the ground that a Western Australian littoral species was unlikely to occur unchanged at Sydney, he selected Gould's name as above given, influenced by the known locality of Gould's species. There was on record an earlier name, *Emarginula conoidea* Reeve, figured in Conch. Syst., Vol. ii., 1842, Pl. cxl., fig. 7, where a view of the interior is given. Reference is made to the P.Z.S., 1842, where (on p. 50) the species was described from unknown locality, in the collection of W. Walton, Esq. A. Adams (Proc. Zool. Soc. Lond., 1851 (1852), p. 87) quotes Reeve's name in the synonymy of *rugosa* Quoy and Gaimard, giving locality "Australia M.C." The specimens regarded by A. Adams as belonging to *rugosa* Q. and G. were eastern Australian shells, and the interior view of Reeve's species shows a peculiar coloration of the spatula, as far as I can judge, characteristic of the Peronian form. I have compared long series of this with shells from Port Fairy, Vic., Port Lincoln, S. Aust., and Busselton, W. Aust., and I conclude the two forms are separable. At any rate, the shells from Caloundra, Q'land., Sydney Harbour and Twofold Bay, N.S.W., Mallacoota and Lakes Entrance, Vic., all in the Peronian Region, are similar and separable at sight from the Port Fairy (Vic.) shells, which are comparatively taller, the apex less central, the anterior slope more arched, the posterior steeper not spreading basally, sculpture finer and more regular. These differences are specially well seen in immature specimens, as aged ones are dirty, worn, and ill-shapen.

I introduced for this group the name *Montfortula*, and suggested its nearer relationship with the Australian *Emarginula* (such as *candida* A. Adams) than with *Hemitoma* s. str., and my more complete knowledge of the groups amply confirms my judgment, and I am now making a study of the radulae, so that in my next communication the facts will be so conclusive that no further argument will be necessary.

(381 A) EMARGINULA DEVOTA Thiele.

Emarginula devota Thiele, Conch. Cab. (Küster), Bd. ii., Abth. 4a, heft xxxvi., 1915, p. 81, Tab. 9, figs. 27, 28, 29: Port Jackson, N.S.W.; Hedley, Proc. Linn. Soc. N.S.W., xlviii., 1923, p. 307.

At the Kermadec Group I dredged a shell which, though Emarginuloid, presented a slight internal shelf, and I named it in MS. *E. connectens*, proposing to deal with the interest attached to such a shelf. Oliver, when later recording the Kermadec mollusca, did not include this new species. Thiele, at the quotation above given, has legitimatised the name, and, at the same time, proposed the present species, closely allied, from the mainland. I have seen the group represented, in the collection made at Lord Howe Island by Roy Bell, and also sorted out a couple of specimens from the deeper dredgings from the Twofold Bay district, and I have found it in shell-sand collected at Coogee, near Sydney. The characters of the group for which I propose the generic name *Subzeidora* (type *E. connectens* Thiele) are clearly marked: the small size, very long anterior slit, arched back with incurved posterior apex, being diagnostic without reference to the important internal shelf.

Thiele has recorded some of the interesting items I had written up some years ago, but, as Thiele's work will not be in the hands of the majority of the readers of this note, I may briefly indicate some of the peculiarities of Fissurelloid molluscs. In this family the same shell condition appears to have been achieved by means of different evolutionary processes, and consequently coincidence or rather agreement in shell features is not conclusive evidence of animal relationships. Further, the complexity of the radula necessitates prolonged study of much material, and this is not yet available. Clues to the alliances of some species may be seen in the juvenile stage growths, but here again all is not clear.

Thus in *Fissurella* the "keyhole" formation in the apical foramen is obvious in some specimens and just as certainly absent in others. At first a high value was placed on this feature, but, when the same species was seen to show both styles, the character was rejected as absolutely valueless. More careful consideration might have shown that the facts could be reconciled in this way: some species begin with a keyhole and this persists in the adult; other species begin with a keyhole and at a later stage deposition, internally, of callus destroys the keyhole appearance; thirdly, no keyhole shape is seen either in the young or adult. Consequently, it is suggested that no juvenile without a keyhole form can produce an adult with a keyhole, while the reverse does occur. Thus, the keyhole juvenile shells show a different group from the ones that have no keyhole form in the young shells.

The internal shelf, persistent in the genus *Zeidora*, appears to be an ancestral feature, as it is seen in connection with most other groups. Thus, the evolution of the European *Fissurella*, from study of the growth stages, was demonstrated by Boutan (Arch. Zool. Exper., iii., 1885, p. 102, Pl. xlii., f. 5) and most of the stages are represented commonly as different groups, but, since then, other groups have been observed, showing different combinations. Granted that *Rimula* constitutes an arrested stage in the development of *Fissuridea*, there is a peculiar species of *Emarginula*, *Semperia paivana* Crosse (Journ. de Conch., 1867, p. 76, Pl. ii., fig. 2) from the Madeiran seas, which is an *Emarginula* until senile, when it closes the slit entrance. There is no shelf in these, but, in the group known as *Cranopsis*, a typically Rimuloid form, there is a large internal shelf, so that it has been generally called *Puncturella*. The species classed

as *Puncturella* are of different shapes, simply agreeing in being conical, and in the possession of an internal shelf. The deep-sea forms known as *Cranopsis*, such as *Rimula asturiana* Fischer (Journ. de Conch., 1882, p. 51) are represented in Austral seas by the magnificent *Puncturella corolla* Verco (Trans. Roy. Soc. S. Aust., xxxii., 1908, p. 193, Pl. xi., figs. 1-5). This group I name *Rimulanax*, with *P. corolla* as type.

The South African species classed at present in *Fissuridea* (*Glyphis* olim) show the remains of an internal shelf, a feature never seen in any Australasian species yet examined. We can arrange a series, from non-slit to apical-perforate shells without an internal shelf, and we can nearly parallel it, at present, with groups showing the shelf persistent, as, *Scutus* and *Tugalia*, *Montfortula*, *Emarginula*, *Rimula* and *Fissuridea*, with no internal shelf, then the first two groups unrepresented, *Zeidora*, *Subzeidora*, *Cranopsis*, *Puncturella* of many kinds and the South African *Fissuridea* with internal shelf, probably with offshoots in many directions as *Emarginella* and *Scutus* with huge animals, *Subemarginula*, *Fissurellidea* and then the *Amblychilepas* series ranging to *Macroschisma*, all of which have lost the shelf while developing the animals, mostly with perforate semi-patelloid shells. Moreover, it is suggested that these groups have evolved independently in their various geographic homes.

(382) MEGATEBENNUS CONCATENATUS (Crosse and Fischer, 1864).

This peculiar form appears almost unchanged in South Africa, the shell found there being still called by Crosse and Fischer's name, given to a South Australian species. Tenison-Woods has also recorded it as fossil, noting a slight difference between the fossil and recent shells, and also between the New South Wales and South Australian shells. It is, therefore, obvious that its peculiarities are of genetic importance, and I propose the new generic name *Cosmetalepas* with Crosse and Fischer's species as type. The shells I have received from the Twofold Bay district were dredged dead in the 50-70 fathom hauls off Green Cape, though a young dead shell was found in the shallow water dredgings, 10-15 fathoms, near Gabo Island, Victoria. I find it not uncommon as dead shells on the Sydney beaches, and there appears to be definite variation from the South Australian shells. Chapman and Gabriel have recently been unable to separate the fossils from the recent shells, probably on account of insufficient material.

(383) MEGATEBENNUS JAVANICENSIS (Lamarck, 1822).

In the Man. Conch. (Tryon), Vol. xii., pt. 47, 16 Dec., 1890, Pilsbry monographed the Fissurellids, and (on p. 182) introduced the new genus *Megatebennus*, the American species, *Fissurellidea bimaculata* Dall being named as type. Two pages later, he proposed *Amblychilepas*, as a section, naming as type, *F. trapezina* Sow., the Australian shell here recognised as *javanicensis* Lam. The animal characters of the Australian forms have proved different in all the cases yet investigated, so there is no need to continue the usage of *Megatebennus*, but *Amblychilepas* should be regarded as the generic designation of this species. The series in the British Museum suggests that easily recognisable forms are separable, but I have no long series of my own to confirm this. When Dr. Pilsbry was here last year (1923), he regarded the animal as differing at sight from the American forms, so that there should be no hesitation in rejecting *Megatebennus*: moreover, he suggested the next species was certainly not a *Lucapinella*, neither was it a *Megatebennus*.

(384) Lucapinella nigrita (Sowerby, 1835).

The species under note was included by Pilsbry in his new genus *Megatebennus*, when he proposed the new genus *Lucapinella* (Man. Conch., Vol. xii., pt. 47, 16 Dec., 1890, pp. 179, 195) with type, by original designation, *Clypidella callomarginata* Carpenter, from California. Hedley transferred the Australian species from *Megatebennus* to *Lucapinella*, from study of the animal, but, with our present knowledge of this group, the observed differences were quite sufficient to separate the Australian shell generically. Hedley gave a figure of the radula of his new species *L. pritchardi* (Proc. Roy. Soc. Vict., vii. (n.s.), 1894 (Jan., 1895), p. 197, Pl. xi., fig. 7), and the radula in the Gwatkin Collection, labelled *L. nigrita*, confirms this: i.e., the central tooth is degenerate and pear-shaped, the inner laterals with short somewhat blunt cutting edges, the large outer lateral strongly tricuspid; the marginals being comparatively few and simple, showing no cusps.

Although the radulae of the Fissurellidae are somewhat generalised, comparison with that of *callomarginata* Carpenter, the type of *Lucapinella*, shows striking differendes. In the latter, the central is large and rhomboidal, the inner laterals are similar to those of the preceding, but the cutting edges are more pronounced, while the outer lateral is bicuspid, the third cusp, if present, being very minute and not recognisable, while the marginals are many and notably cuspidate. This radula is more like that of *concatenatus* Crosse and Fischer, but the outer lateral is differently shaped and the marginals are smaller, etc.

I have just remembered Claude Torr's paper, Radulae of some South Australian Gasteropoda (Trans. Roy. Soc. S. Aust., xxxviii., 1914, p. 362), and good figures of the radulae of *M. concatenatus* and *L. oblonga* are given: in the latter it is stated that the marginals are "serrated" and that each row has nine teeth, while in the former each row has twenty-one teeth.

From Port Fairy, Vic., Roy Bell sent a lot of shells of *nigrita*, a few *oblonga*, easily separated by longer shape, narrower, and of coarser sculpture. A few *nigrita* from Melbourne Heads agreed, but specimens from Twofold Bay, N.S.W., were narrower and with more lateral compression, though of same length and with similar fine sculpture. Shells I collected in Sydney Harbour showed the same differences.

The locality given when Sowerby introduced his *Fissurella nigrita* was Cape of Good Hope, but the shells in the Mus. Cuming (two sets), either of which might be regarded as types, are somewhat like the Tasmanian specimens in the British Museum. Consequently, an arbitrary determination of a type locality is necessary, and I here select Tasmania (southern) as such, and now introduce the new generic name *Sophismalepas* with *F. nigrita* as type. I think that Menke's *F. oblonga*, as recognised in Hedley's *pritchardi*, is undoubtedly congeneric. Hedley has recently given a figure of the animal (from Sydney) of this genus.

(384 A) Macroschisma tasmaniae (Sowerby, 1862).

This is a curious addition, if such it be, to the New South Wales list, as one of the first localities cited for the genus is New South Wales. Thus Sowerby (Conch. Illus. Fissurella, p. 5, No. 45, 1839) wrote "*Fissurella macroschisma* Humphrey, Conchology. Conch. Illust., f. 39, New South Wales, var. f. 39*, Swan River. *Obs.* This forms the genus *Macroschisma* of Gray."

The species I have to record was dredged as a dead shell, in 50-70 fathoms, off Green Cape, New South Wales, and the reference reads: *Macrochisma tas-*

maniae Sowerby, Thes. Conch., Vol. iii. (pt. 21), 1862, p. 206, Pl. 244, f. 223, from Tasmania. The next species is *Macrochisma novaecaledoniae* Sow., ibid., p. 206, Pl. 244, f. 222, from New Caledonia, and this is regarded as a synonym in the British Museum Collection, shells sent from Tasmania by R. Gunn being so labelled, the New Caledonia locality false, as in some other cases. A few complications may be here noted,—thus, the shell figured by Humphrey in his Conchology was named *Patella macroschisma* by Solander, and the name published in the Catalogue of the Portland Museum, p. 71, 1786. In the Museum Calonnianum, 1797, Humphrey proposed the genus *Larva,* and this is the only recognisable constituent. In the Genera of Recent and Fossil Shells, pt. 21, Pl. 147, fig. 5 (two views), 1823, Sowerby figured a *Fissurella macroschisma,* in the text referring as a synonym to *F. hiantula* Lam., which has no close relationship at all. Recognising this, Swainson (Treat. Malac., 1840, p. 356), introducing independently a genus *Machrochisma,* gave the name *M. hiatula* to Sowerby's figure. This does not look like the Japanese shell figured and named by Humphrey, nor does it well agree with any Australian species yet known.

A hitherto overlooked name is *Patella lobata* Donovan (Rees' Encyclop. Conchology, 1 Mar., 1881, Plate i.), which apparently refers to the Red Sea species named *M. compressa* by A. Adams (Proc. Zool. Soc. Lond., 1850, p. 202).

(385) DIODORA LINEATA (Sowerby, 1835).

Traditional determination is peculiar in its usage. Reference to Sowerby's figure did not suggest the New South Wales shell, and as it was described from unknown locality, I read the description without hopes of achieving anything tangible, but was surprised to find "Dorsal aperture small, much nearer to the anterior than to the posterior end, *its margin internally truncated posteriorly*": the italics are mine, as these prove Sowerby's species to have belonged to a different group from the Australian shell which does *not* show this feature. Such a shell as *F. listeri* D'Orbigny, from the West Indies, shows a posteriorly truncated aperture, and is very similar in shape to the Australian so-called *lineata.*

The transference of *lineata* to the Australian species seems to be due to Sowerby (Thes. Conch., Vol. iii., Mon. *Fissurella,* pt. 21, 1861, p. 195, sp. 80, Pl. 6, f. 134, 135) who synonymised *incii* Reeve, writing "Although first figured from a smaller specimen, there can be no doubt of the identity of this shell, to which the name subsequently given by Mr. Reeve was therefore unnecessary." *Fissurella incii* Reeve (Conch. Icon., Vol. vi., June, 1850, Pl. 10, f. 69a-b) had been described from Raine Island, Torres Straits, collected by Ince. Pilsbry (Man. Conch (Tryon), Vol. xii., (pref. Apl.), 1890, p. 219) called the species *Glyphis lineata,* giving as distribution: "North Australian Coast," gave figures (on Pl. 63, f. 29, 30) from specimens, and copied Reeve's figures (on Pl. 38, f. 63-64). Consequently, it would seem that, if *lineata* were available (which I deny), it would rather be applicable to the Torres Straits species. In every case I conclude the shell from Twofold Bay is nameless, and I propose to describe it as a new species, and also a new genus. In shell features it approximates fairly closely to the European type, but the apical fissure is different. Examination of the radulae in the Gwatkin Collection in the British Museum shows that similar shells cover different animals, as the radulae vary according to locality.

(385) ELEGIDION AUDAX, n. gen. et sp. (Plate xxxv., figs. 5-6).

A genus of the Fissurellidae with apical perforation of "keyhole" style, and radula somewhat like that of the European *Diodora.*

The sculpture consists of bold radiating ribs, with bold concentric rings latticing the ribs; the shape is oval, not quite twice as long as broad, and more than half as tall as broad, the apex at two-thirds the length. These proportions vary with age: the largest specimen I have in this series measures 55 mm. in length and 35 mm. at the broadest part but narrowed anteriorly to 27 mm.: it is 22 mm. in height just behind the apical fissure. A fairly small typical shell measures 13 mm. long, 9 mm. broad, scarcely any anterior lessening, and 5 mm. high at apex: in the young shells the "keyhole" shape of the perforation is seen with an internal callus surrounding it, and in the senile forms, the fissure, though having lost the keyhole shape, is still regularly oval and does not show a posterior truncation. In the immature the anterior slope is straight and the posterior slope is similar, but in the senile the posterior is convex and the anterior one slightly concave, the fissure being on this slope pointing forwards, not directly upwards as in the young stages. In the earlier stages about forty primary radials can be counted, but, as intercalating secondary ones appear almost at once, and then subsidiary, on the largest clean specimen I have examined I find, between two primary ribs, three secondary and three smaller. In the young shells the concentric rings are about a dozen and form strong nodules at their junctures with the radials, but with age these decrease so that the senile shells show simple latticing, the nodules having disappeared. The muscle scars are scarcely distinguishable.

The animal has been figured and described by Hedley under the name *Fissuridea lineata* (These Proc., 1900, p. 95, Pl. iii., fig. 11) but the coloration must vary, as I have seen many with the mantle pinkish-white dotted with pinkish-red.

(386) Diodora watsoni (Brazier, 1894).

When Brazier described this species, he commented upon its strange facies as probably deserving a new generic name. I separated four shells from the 50-70 fathom dredging off Green Cape, and they differed from any type of Fissurellid I had previously studied. They were solid for their size, and showed a type of Fissurellid with an internal shelf and persistent apex, recalling some *Puncturella* forms, but very distinct from any Australasian form referred to *Puncturella*, of which I have half a dozen.

I hope to discuss these most interesting states later, but I here propose *Rixa* for this species alone, and by this means its later recognition will be assured. I might note, with the eccentricity oft-times apparent in the British Museum collection, this species is placed in *Fissurella* s. str., a position so absurd as scarcely to call for comment. Judging from shell features, it would not even belong to the subfamily containing *Fissurella*. I find it not uncommon as dead shells on the Sydney beaches, but have not yet met with it alive.

(388) Puncturella demissa Hedley, 1904.

This species was described by Hedley from New Zealand, and later when he found the form in Australian waters he gave a good illustration of this, though accepting the Neozelanic name. Comparison of the two figures will show that differences of form exist, and I propose to name the Australian shell *Vacerra demissa menda*, citing Hedley's figured specimen (Rec. Aust. Mus., vi., 1907, p. 289, Pl. 54, f. 3-5) as type, the generic name *Vacerra* being provided for the small Austral forms ascribed to *Puncturella*, but which do not closely agree, even in superficial features, with the type of that genus. The present species I name as

type of *Vacerra*, but do not conclude that all the species, even in the N.S.W. List, will prove later to be congeneric. This species was found in the Green Cape 50-70 fathom dredgings, but the other two species listed by Hedley as *Puncturella* were found in shallow water dredgings. I have a new species Roy Bell found alive, under stones, at low tide at Lord Howe Island, which appears to be the first met with in such a situation in Austral waters. I hope to report fully upon it later.

(391-394) Family HALIOTIDAE.

This family provides an excellent illustration of the difference between the Peronian and Adelaidean faunas. Hedley admits, in the former, four species *brazieri, coccoradiatum, hargravesi*, and *naevosum*, while in the Victorian List appear *albicans, conicopora, cyclobates, emmae*, and *naevosa*, Verco adding, in South Australia, *roei* and *tricostalis*, noting that the correct name of the latter may be *scalaris* (which it is) and that *emmae* may only be a variant thereof. Roy Bell secured all the four N.S.W. species at Twofold Bay, *naevosum* alive and the other three dead, the rare ones in dredgings, while he also sent from Tellaburga I., Vic., specimens of *coccoradiatum*, an addition to the Victorian List. From Port Fairy, Vic., he sent a fine series of the so-called *naevosum, emmae* and *albicans*, all living: the *naevosum* are easily separated from typical Sydney shells by their more elongate shape, less tightly coiled and higher spire, showing the whorling inside, and probably larger size and stronger sculpture. I propose to differentiate these as *Haliotis naevosum improbulum*, n. subsp. Another correction may be here made: *Haliotis laevigata* was given to a beautiful figure published in Rees' Encyclopaedia. The plate was published on 1 Nov., 1808, on Pl. vi., of the Conchological series, and the author was Donovan. This has never been recorded previously, but the shell figured is undoubtedly *H. albicante* of Quoy and Gaimard, whose name is a quarter of a century later. It may be noted that Peron mentioned a *Haliotis gigantea* from D'Entrecasteaux Channel, Tasmania; no description was offered, but apparently this was given to the southern Tasmanian form of *H. naevosum* Martyn, which is, in shape, like the Sydney form and differs from the Port Fairy series, while in sculpture it can be separated from typical *H. naevosum* in lacking the pronounced radial striation and in its larger size. It will bear the name *Haliotis naevosum tubiferum* Lamarck (Hist. Anim. s. Verteb., Vol. vi., pt. 2, 1822, p. 214), described from New Holland, probably from one of Peron's shells. Lamarck cited "Chemnitz 10, t. 167, f. 1610-11 and Martyn 2, f. 63." In the first place Chemnitz figured a Japanese shell from Spengler's collection confusing it with the species found in New Holland and figured by Martyn from New South Wales as *naevosum*. When Hedley revived Peron's name of *Haliotis cyclobates* for *excavata* Lam., he observed "At Kangaroo Island, a *Haliotis* whose perforations project so as to form open truncated cones, Peron named *H. conicopora*. This answers to the *H. tubifera* of Lamarck, which has been referred to *H. naevosa* Martyn, but which may perhaps be *H. granti* Pritchard and Gatliff." In making this identification, Hedley overlooked the data given by Lamarck for his *H. tubifera*, viz., "maxima five inches 10 lines long by 4 inches broad." This does not agree with *conicopora*, which is probably *emmae*, a form of *tricostalis* == *scalaris*, over which names Peron's name has priority. The size of Lamarck's *tubifera* agrees with the southern Tasmanian shell, the name recorded by Peron being the same as that of Chemnitz, and the figure of Martyn agreeing generally. J. E. Gray (Proc. Zool. Soc. Lond., 1856 (11 Nov.), p. 148) introduced a new generic and specific name, *Schismotis excisa*, for a specimen

figured on Moll., Pl. xxxiv., which he afterwards concluded was a monstrosity of *Haliotis albicans*. This name seems to have been overlooked, and is available for this peculiar species when separation is desired.

(395) STOMATELLA IMBRICATA Lamarck, 1816.

The introduction of the specific name is correctly given, but a later one is cited for the generic, a quotation which needs correction, as both were first proposed at the same entry. I have been unable to detect any constant differences in the shells referred to this species from different localities, mainly on account of their variability.

As the generic name *Tliboconus* Peron is sometimes quoted as a synonym, I give here the extract and quotation which should read, "*Tliboconus* Blainville, Dict. Sci. Nat. (Levrault), Vol. liv., p. 467, 1829. "Tlibocone. *Tliboconus* (Conchyl). This name I have found on a shell in the Coll. Mus. Paris, naming a genus made by Peron. This shell has passed, I believe, into the genus *Stomatella* of Lamarck." Lamarck's description and figure were probably based on Peron's examples, and the locality given, "Java," false, the shells being collected in southern Australia, probably south-western Australia.

(396) GENA STRIGOSA A. Adams, 1851.

Recently Hedley has given some detail of the animal of the Sydney *Gena*, and has accepted A. Adams's name, as I had compared for him Sydney specimens with A. Adams's types in the British Museum. He did not discuss the Victorian form, for which Pritchard and Gatliff had used the name *Gena nigra* ex Quoy and Gaimard, and quoted A. Adams's name as synonymous. Specimens from Port Fairy, Vic., sent by Roy Bell, differed a little from the Twofold Bay shells, which agreed with Sydney shells I had collected some years before. The Victorian shells are absolutely larger, a little differently shaped and with generally coarser sculpture. Inasmuch as the two forms have been continually regarded as distinct, these differences may be emphasised, but the nomination is a matter of difficulty. Lamarck named and figured *Stomatella auricula* (Tabl. Ency. Method, 1816, Liste, p. 10, Pl. 450, figs. 1a-b). In the Hist. Anim. s. Verteb., Vol. vi., pt. 2, Apl., 1822, p. 210, *Patella lutea* Lin. Gmel., p. 3710, No. 94, was synonymised and three references to Rumph., Favanne and Martini added, the locality being given as "Habite l'Ocean des Moluques et de la Nouvelle Hollande." Although Hedley admitted *nigra* Quoy and Gaimard in his Western Australian List, he has since received specimens from the Pacific Islands, now in the Australian Museum, exactly agreeing with the description, by Quoy and Gaimard, of a Tonga Tabu shell, and now eliminates the name from Australian usage, a conclusion I had arrived at from study of the British Museum collection. Further, he had determined specimens from Kangaroo Island as Lamarck's *auricula*, and in this determination I was inclined to agree when I met with Quoy and Gaimard's statement in the Voy. de l'Astrol., Vol. iii., p. 309, which absolutely clinched the matter, viz., "*Stomatella auricula* Lam. Nous avons constaté que nos individus provenaient du meme lieu que celui qui est au Muséum, et qui Peron avait rapporté du port du Roi Georges, à la Nouvelle Hollande." On this evidence we can accept Lamarck's name for the Western Australian shell which ranges along the Adelaidean Region as far as Port Fairy, Vic.

The earliest recognisable name for the eastern Australian shell seems to have been overlooked, viz., *Haliotis impertusa* Burrows (Elements of Conchology, 1815,

p. 162, Pl. xxi., fig. 2): no locality given, but probably Port Jackson, as Burrows had shells from that locality. The figure and description are good and are easily matched by a shell from any day's collecting in this locality.

(398-436) Family TROCHIDAE.

Probably only second in interest to the family Fissurellidae, Trochoids, on account of the simplicity of their shell formation, present more difficulty, but still are delightful on account of their littoral habit and their rapid alteration as they descend into deeper water. In the two Regions here contrasted, the Peronian and Adelaidean, the species continually represent each other, and only in a few instances does the same species occur in both regions unchanged, and then usually only in the territory adjacent. Consequently, it is comparatively easy to indicate errors such as the admission of *Clanculus maugeri* Wood into the Victorian and Tasmanian Lists, this being a northern Peronian species which apparently does not travel so far south.

(403) CLANCULUS OMALOMPHALUS (A. Adams, 1853).

In the Proc. Zool. Soc. Lond., 1851, not published until 1853, A. Adams named numerous species of Trochoids, generally without definite, or else inaccurate, locality. The name *C. omalomphalus* has been used because it was noted that it had been collected at Sydney by Strange. On the previous page, he had described *Clanculus brunneus* from an unknown locality, and Mr. J. R. Le B. Tomlin finds, from examination of the types in the British Museum, that these are the same species.

This species, along with *C. floridus* Philippi (No. 401), was sent from Tellaburga Island, Vic., and they are additions to the Victorian List. From the series sent from Port Fairy, Vic., *C. flagellatus* Philippi appears to be the Adelaidean representative of *C. floridus* Philippi, while *C. limbatus* Quoy and Gaimard replaces *C. brunneus* A. Adams as above. These Adelaidean shells, according to May's Illustr. Index Tasm. Shells, 1923, Pl. xviii., occur on the eastern coast of Tasmania, a record which is suggestive that the Peronian Trochoids do not occur in the Maugean Region.

(404) CLANCULUS PLEBEJUS (Philippi, 1851).

This species is very puzzling, specifically and generically. To deal with the latter item first, the species has been classed in *Clanculus* and also in *Gibbula*, two very distinct groups, and now Hedley has transferred it to *Eurytrochus*. The false umbilicus, with the columella joining on the outside, differentiates it from all the above, but, as it seems to approach the first-named genus, I propose to separate it with the new generic name *Mesoclanculus*. Hedley recently added it to the N.S.W. List from Montagu Island, a little north of Twofold Bay, but Angas had included it from Port Jackson as *Clanculus nodoliratus* A. Adams. The latter name was proposed in the same year as Philippi's, but not published until two years afterward.

Philippi's description and figure do not fit the New South Wales shells (which I have found on the Sydney beaches), but are quite good for the Western Australian form, which appears common. From Port Fairy, Vic., Roy Bell sent it as a very common species, very variable in size. There appears to be a series of names for the eastern shell, as Tenison-Woods is credited with two, *Clanculus angeli* and *Gibbula multicarinata*, described in the same paper (Proc. Roy. Soc.

Tasm., 1876, pp. 144 and 142), the last-named having priority. Then A. Adams's name would need consideration, but the selected epithet is not well applicable to the eastern shell. Fischer (Coquilles Vivants, 1880, Trochus, p. 243. Hab ?) separated a small form as *Trochus muscarius*, and the description agrees with the smaller shells found at Port Fairy, Vic. and the Peronian shells so far examined.

Pilsbry (Man. Conch., Vol. xi., 1889, pp. 80-81) writes, "To this (typical) form Dr. Fischer gave the mss. name *T. muscarius*, which he considers as var. B. of *plebejus*. . . . . In the Academy collection (shells) are marked *C. rubicundus* Mighels: but I have seen no description of such a species by that author." I do not consider Fischer's *muscarius* typical of *plebejus*, but would note *C. rubicundus* (Mighels) Pilsbry in the synonymy of *plebejus*. Later, in the same volume, Pilsbry suggested (p. 467) that *C. rubicundus* Dunker was perhaps intended.

(409) Cantharidus fasciatus (Menke, 1830).

Three very different species have been included by Hedley in the genus *Cantharidus*, each of which has been long allotted a separate name. The first, No. 408, *Cantharidus eximius* (Perry, 1811) may be allowed to represent that genus, very little difference being seen between it (the type of *Phasianotrochus*) and the Neozelanic type of *Cantharidus* (*opalus* Martyn). The present species, the type of *Bankivia*, a MS. name by Beck, apparently first published by Krauss (Die Sudafr. Mollusk., Jan., 1848, p. 105, Pl. vi., f. 7) by monotypy, should be absolutely separated, although at present a monotypic genus. The radula is quite peculiar and recognisable at sight among these Trochoid forms.

(410) Cantharidus lineolaris Gould, 1861. (Plate xxxvi., figs. 1-2, 17).

This is the monotype of *Leiopyrga* H. and A. Adams (Ann. Mag. Nat. Hist., 3 Ser., Vol. xii., 1863, p. 19), a genus which should be recognised. The extreme variability of the species is seen in the hundreds of specimens now before me. All were dredged alive on grass beds (*Zostera*) in the Bay, in from 5 to 10 fathoms of water. This species commonly shows a peripheral keel and specimens (immature) are found agreeing exactly with the type, figured by Hedley, of A. Adams's *cingulata*. I had intended to suppress that species as synonymic, but, fortunately, found two tablets in the British Museum, one from Sandy Cape, N. Queensland, and the other from Port Essington, Northern Territory, which showed that the northern species was permanently smaller and constantly keeled. Among the hundreds from Twofold Bay shallow water dredgings I found half a dozen specimens showing the whole of the whorls strongly spirally lirate, suggesting Tate's *octona*, and it seems doubtful whether these are stragglers from the Adelaidean Region or merely aberrations. Though only a few specimens were found in a dredging made off Gabo Island in Victorian waters, yet one was of the *octona* type. Under these circumstances, it seems wise to accept three species, quite representative, but probably entering each other's regions at the point of junction. Verco, from a study of South Australian shells, was fain to conclude that *octona* was no more than a validly spirally lirate variety of the Sydney species. As the variation seen in the Twofold Bay series is very great, it is possible that the fossils described by Tate (Trans. Roy. Soc. S. Aust., xiv., Dec., 1891, p. 261), as *Leiopyrga quadricingulata* and *L. sayceana* may prove synonymous with each other or else inhabit different horizons.

The reference to *Leiopyrga octona* Tate is as above (p. 260, Pl. 11, f. 5), two

examples, one from Royston Head, S. Yorke Peninsula, the other from King George Sound: this species should be added to the New South Wales fauna, pro. tem., as I also find specimens from Sydney Harbour in the Australian Museum, separated from the smooth shells, which also occur there. I, therefore, name the Peronian form *Leiopyrga octona problematica*, n. subsp., type from Twofold Bay.

(415) Calliotrochus coxi (Angas, 1867).

The shell named *Gibbula coxi* Angas bears a superficial resemblance to the European *Gibbula*, but has little real relationship, and I propose the new generic name *Notogibbula*, with this species as type. J. R. Le B. Tomlin, while arranging the Trochoid shells in the British Museum, noted that this species had been previously described by A. Adams as *Stomatella bicarinata* A. Adams (Thes. Conch., Vol. ii. (pt. 15), 1854, p. 839, Pl. 175, figs. 39-40), from Moreton Bay, Australia, the types being preserved in the Mus. Cuming. An alternative reference is to the Proc. Zool. Soc. Lond., 1853 (25 July, 1854), p. 74. The Western Australian *G. preissianus* Philippi, recently placed in *Gibbula*, e.g., by Pritchard and Gatliff, and classed under *Monilea*, subgen. *Minolia* by Pilsbry, appears congeneric. Hedley has recently proposed to transfer *lehmanni* Menke (= *preissianus* Phil.) and *bicarinata* Adams (= *coxi* Angas) from *Gibbula* to *Minolia*, but, as I show later, they would not be settled in that genus.

(416) Calliotrochus tasmanicus (Petterd, 1879).

When Hedley and May described *Gibbula galbina* (Rec. Aust. Mus. vii., 11 Sept., 1908, p. 114, Pl. xxii., f. 2) from 100 fathoms off Cape Pillar, Tasmania, they observed that this was the species recorded as *G. tasmanica* from the *Thetis* results, in 63-75 fathoms off Port Kembla, N.S.W.

Apparently *C. galbina* must be added to the N.S.W. List, as *G. tasmanica* Petterd, according to the British Museum, occurs as far north as Port Jackson. In any case, similar shells occur in the shallow water dredgings from Twofold Bay. *Calliotrochus* was proposed for *Turbo phasianellus* Deshayes, a form quite peculiar, of which the Mauritius form is almost indistinguishable from the New Caledonian one conchologically, but my Lord Howe series are easily separable from the Norfolk Island one, and the genus also occurs at the Sandwich Islands. The radular features of this genus are very peculiar and distinct, so that members of the genus can be easily exactly determined.

(416 A) Minopa legrandi (Petterd, 1879).

Petterd (Journ. Conch. (Leeds), ii., 1879, p. 104), described *Fossarina legrandi* from northern Tasmania, and Pritchard and Gatliff recorded it as "a rather common little species widely distributed along our coast," transferring it to the genus *Gibbula*, and simultaneously, Tate and May figured it, also placing it in the genus *Gibbula*. From Tate and May's good illustration it was easily recognised as common in the shell-sand sent from Port Fairy, Vic., by Roy Bell. Later a few were picked out of shell-grit sent from Twofold Bay, N.S.W., so that it seems a new record for the latter State. Owing to the generic splitting now necessary, this form requires a new location, and I therefore propose *Minopa*, citing this species as type.

I have noted about *Calliotrochus*, and hope that the radula of this species will

soon be examined, as well as that of the preceding. Until this is done the species *tasmanicus* may be classed in *Minopa*, but I do not think it will stay there.

(418-426) MONILEA and MINOLIA. (Plate xxxv., figs. 7-12).

Hedley refers to the former genus, *angulata, lentiginosa, oleacea,* and *vitiliginea,* and to the latter *arata, bellula, philippensis, pulcherrima* and *rosulenta.* In Proc. Malac. Soc. Lond., xiii., Aug. 1918, p. 36, I drew attention to the invalidity of *Monilea,* and concluded that *Talopia* Gray, which first appeared in the Synops. Contents Brit. Mus. (of which I have given full details in the Proc. Malac. Soc. Lond., x., Mar., 1913, pp. 294-309), 42nd ed., p. 147, 1840, as a nomen nudum, and in the 44th ed., 1842, p. 57, with the following definition. "The *Talopia* are like the *Rotella;* the shell is striated and umbilicated, the umbilicus being edged with a striated callus edge," could be used from the next entry. Only the species *lentiginosa* of the above list would fall into *Talopia,* while *Minolia* was proposed for a species from Japanese seas having the conchological features seen in *pulcherrima,* and for the present *pulcherrima, arata* and *rosulenta* may be classed here. I had, from conchological features, separated the group like *philippensis,* when Lt.-Col. Peile, to whom I had given specimens to extract the radulae, informed me that the radula in this species was very peculiar. I therefore propose the new generic name *Spectamen,* and name Watson's *Trochus philippensis* as type (Plate xxxv., f. 11). The species *bellula* is so close to this, that it seems a geographical representative, but Hedley has recorded both from localities not very far apart.

From the description, *oleacea* represents still another distinct group, which I did not receive in these collections, but which Roy Bell dredged at Lord Howe Island, and which strongly recalls *Umbonium.* Since the preceding was written, consideration of radulae in the Gwatkin collection shows the radula of *Talopia* (*callifera*) to be distinctive, and that, of two slides labelled *vitiligenea* from South Australia, one shows a Trochoid radula unlike that of *philippensis* (*Spectamen*), but the other radula is different and is of the style peculiar to *Umbonium,* about which I hope to write more later. This latter radula appears to belong to the true *vitiligenea,* which from shell features is an *Ethminolia. Machaeroplax* was instituted by Friele for a northern shallow water Trochoid of simple character on account of the peculiar radular features. Later it was suppressed in favour of the earlier *Solariella,* proposed for a fossil species, not exactly agreeable even in shell characters. *Minolia* was named for a Japanese shallow water form, not much unlike in shell features, and has also been suppressed. In the northern "*Solariella,*" two forms of radula are seen, the *Machaeroplax* style and a regular Trochoid form. The radula of *Spectamen* proves to be comparable with that of *Machaeroplax,* but I can see differences which decide me in favour of not using the northern name, especially as the shells differ. It is probable that the radula of *Minolia* (which is as yet unknown) will agree fairly closely in style with that of *Spectamen,* but the fact that the species known as *angulata,* very similar in shell character to the type of *Spectamen,* shows a very different radula, demands the use of analogy with extreme caution. The continuous distribution of the Minolioid shells decided me in my tentative use of that generic name.

(418) MONILEA ANGULATA (A. Adams, 1853).

This species was described from the Sandwich Islands and the name should not be used for a Sydney shell: *T. prodictus* Fischer is simply a new name for

Adams's *angulata*, and must be referred to that species, although Fischer used it for the Australian one. *Monilea apicina* Gould has nothing to do with the present form, although Hedley, at the quotation given, recognised a photo of the type sent by Dr. Bartsch, as of this species. It should be recorded that Gould brought his shells to London for comparison with the Cuming collection, and that he gave to Cuming typical specimens of his species, and that, upon his return, his shells were lost and mislaid, and probably the most authentic representatives of his species are the shells in the Cuming collection, now in the British Museum. In the present instance, there is a specimen labelled "*Monilea apicina* Gould," with reference and locality, and this is obviously not even congeneric in a broad sense with the shells referred to Adams's species. Reference to the original description shows this shell to be typical, and I only quote the following items "Testa ovato-conica . . . . basi convexo, lineis incrementi nonnihil granulatis: umbilico minuto, costâ callosâ marginali et alterâ interiori cincto," as showing the attachment of the species to Adams's *angulata* to be quite inaccurate. I was fortunate in being able to recognise, in Gould's species, the Lifu shell described as *Minolia agapeta* by Melvill and Standen, and probably the locality, "Port Jackson, W.S.," is wrong.

The use of Adams's name seems to depend upon a tradition now lost. Fischer figured a Sydney shell as *prodictus*, his unnecessary substitute for *angulata*, but I have been unable to trace Adams's type shells and here give the latter's description: "M. testa orbiculato-conica, late umbilicata, albida, fusco variegata; anfractibus supra angulatis, transversim omnino striatis; basi convexa, concentrice striato, umbilico magno perspectivo."

This description is very vague and may easily apply to a Sandwich Islands' species. In the Museum Godeffroy Cat., iv., 1869 (p. 102), there were offered for sale specimens of *Margarita angulata* A. Adams from the Sandwich Islands, and as I have been unable to trace any authentic specimens to throw light upon the subject, either to discredit the named locality or to legitimatise the adopted one, I here describe the shell from Twofold Bay, N.S.W., as a new species. This is the more necessary, as I have also to provide for it a new generic name, as examination of the radula proves it to differ essentially from that of *philippensis*, with which I had tentatively classed it from shell features, and is of the style termed Umbonioid. I here propose to describe the species (known as *angulata* A. Adams) as

ETHMINOLIA PROBABILIS, n. gen. et sp. (Plate xxxv., figs. 7-9).

Shell depressedly trochoid in shape, widely umbilicate, texture thin, whorls medially angulate, and with strong square shoulder.

Colour variable, of shades of brown with white spots and blotches irregularly placed, but sometimes whitish with regular brown rays of various widths. The apical whorls are minute, white and smooth; the adult whorls are sculptured with dense fine transverse lines, rarely, on the shoulder, one or two stronger than the rest. Umbilicus perspective exposing all the whorls, the edges neither crenulate nor angulate, though growth lines can be noted on the base. Mouth subquadrate, outer lip thin, columella simple, a little convex, but bearing no tooth, nor is the mouth complete or detached. Operculum circular, horny, multispiral. Radula, resembling that of *Ethalia*, with degenerate rhachidian and laterals, and with marginals of a rather normal rhipidoglossate form. Breadth 7½; height 4 mm.

Common in shallow water dredgings at Twofold Bay, N.S.W.

(425) MINOLIA PULCHERRIMA Angas, 1869.

Roy Bell dredged many beautiful specimens in Twofold Bay in 10-25 fathoms, and these agreed with shells so named in the British Museum, but not so clearly with the description and figure. The radula was extracted from such shells by Lieut.-Col. Peile, and reported upon (Proc. Malac. Soc. Lond., xv., 1922, p. 17), under Angas's name. The radula agrees fairly closely with that of *M. philippensis* Watson, whose shell differs. As discussed above, I propose to retain the name *Minolia* for shells like *pulcherrima* for the present. However, in the Australian Museum Collection I found shells from Middle Harbour, Sydney, which agreed exactly with Angas's description and figure. The deeper water Twofold Bay shell, which I propose to name *Minolia pulcherrima emendata*, n. subsp. (Plate xxxv., f. 12), differs in being smaller, with the encircling lirae more regular and closer together, so that the whorls show no shouldering, and the two prominent keels of the type are missing. In view of the complexity of the relationship of the species, this may hereafter prove of specific value.

(429) CALLIOSTOMA DECORATUM (Philippi, 1846).

This species was introduced as *Trochus decoratus*, and previously *Trochus decoratus* had been used by Hehl (C. H. v. Zieten, Petref. Wurtt. (6), 1832, p. 46).

When Hedley selected the above name (These Proc., xxvi., 1901, p. 19) he ranged as synonyms, *Trochus fragum* Philippi, *T. pyrgos* Philippi and *Thalotia zebrides* A. Adams. In his more recent W.A. List, he has admitted as a distinct species *Cantharidus pyrgos* Philippi, citing as synonym, *C. moniliger* A. Adams. This appears to leave Philippi's *fragum* as the species name (the reference being Zeitschr. fur Malak., 1848 (Feb., 1849), p. 106. Loc. unk.) while *Thalotia zebrides* A. Adams, from study of the types, has nothing to do with this species. Nevertheless, I cannot see why this species should not be classed in *Thalotia*, as it is not a *Calliostoma* commonly so-called. The radula of *Thalotia* is quite different from that of *Calliostoma*.

(430 A) CALLIOSTOMA LEGRANDI (Ten.-Woods, 1876).

Zizyphinus legrandi Tenison-Woods, Papers and Proc. Roy. Soc. Tasm., 1875 (1876), p. 154: Chappell Island, Bass Straits.

Specimens of this species from Twofold Bay appear to be a new record for New South Wales. With it, among the deep water dredgings, was an odd specimen of another species, also lacking nodules, but of the shape of *C. comptus* A. Adams, which was also sent from Twofold Bay. In the Victorian List, Pritchard and Gatliff used *poupineli* Montrouzier for *comptus* A. Adams, and when Hedley recently acknowledged that A. Adams's species was his Sydney *purpureocinctum*, he stated he had not seen Montrouzier's species. In the British Museum there are now shells from New Caledonia, identified as *poupineli*, and these agree with Montrouzier's description, and also with Fischer's figure, and are easily separated from the Australian form, even as Brazier determined years ago from examination of New Caledonian shells.

(430 B) CALLIOSTOMA ALLPORTI (Ten.-Woods, 1876).

Zizyphinus allporti Ten.-Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 155: Bass Straits, Tasmania.

This species is also an addition to the N.S.W. List, and Lt.-Col. Peile, who

has examined the radulae of the Austral species in the Gwatkin Collection, now in the British Museum, informs me, as I suspected, that these show notable differences from those of the Northern forms, the true *Calliostoma*, and also, as in the Palaearctic, the small forms are separable from the large similarly-named species.

I, therefore, propose the new genus *Salsipotens*, naming *Trochus armillatus* Wood as type, and *Fautor* for the small species; naming *Z. comptus* A. Ad. (= *C. purpureocinctum* Hedley) as type.

A lovely species, occurring in Victoria and Tasmania, but not found by Bell in N.S.W., is *Trochus nobilis* (Philippi, Conch. Cab., ii., pp. 86 and 255, Pl. 15, f. 6, and Pl. 38, f. 1, from Western Australia) figured by May in his Illustr. Index Tas. Shells, 1923, Pl. xix., f. 19, from King Island. The specific name had been previously chosen by Muenster (N. Jahrb. fur Min., 1835, p. 443) but there is a substitute, *T. rubiginosus* Valenciennes.

(431) Astele scitulus (A. Adams, 1855).

This common Sydney shell was sent from Twofold Bay, N.S.W., and also from Mallacoota and Tellaburga Island, Vic. With it from Mallacoota came a specimen of *Astele subcarinata* Swainson, the type of the genus, and this showed that the present species could not be regarded as congeneric, the formation of the umbilicus, the only common character, being of a different nature. From the apical features, it suggests somewhat a loosely coiled form of the "*Calliostoma*" series, and I propose the new generic name *Astelena* for this species.

It is not uncommon at Mallacoota, Vic., and appears to be an addition to the Victorian List, while, on the other hand, true *Astele* will later be found inside the New South Wales limits, as I received it from Mallacoota. The radula of *scitulus* is separable from that of *subcarinatus*, the type of *Astele*.

(434) Euchelus baccatus (Menke, 1843).

This species, introduced as a *Monodonta*, does not agree with the type of *Euchelus*, which is the tropical *atratus* Gmel. (a shell I collected at Port Curtis, Queensland), in umbilical, columellar and opercular features. It would be better placed in *Herpetopoma* proposed by Pilsbry (Man. Conch., Vol. xi. (pt. 44), Mar., 1890, p. 430), for Angas's *scabriusculus*, which was described as "umbilicated," but the type series show that feature to be very indistinct.

Menke called the present species *Monodonta baccata*, and that combination had been previously introduced by Defrance (Dict. Sci. Nat. (Levrault), Vol. xxxii., 1824, p. 475), for a Paris fossil.

The next synonym is *Trochus aspersus* Philippi (Zeitschr. fur Malak., iii., July, 1846, p. 103), as of Koch, from unknown locality. The radula of *scabriusculus* is separable from that of *atratus*, but both belong to the same group, and are distinguishable from *Clanculus*.

(437) Phasianella perdix Wood, 1828.

In the Vict. Nat., xxxi., 10 Sept., 1914, p. 82, Gatliff and Gabriel superseded the well-known *Phasianella ventricosa* Quoy and Gaimard, 1834, by *P. perdix* Wood, 1828, which was chronologically correct, and has been accepted by Hedley in his Check List.

It has been overlooked, that, in the Appendix to the Cat. Coll. Shells Bligh, Swainson had described this species twice, first under the name *P. ventricosa*,

which can be therefore preserved, and then as *P. inflata.* As usual with Swainson's work, there is confusion at every stage, and we see on the first page of the Catalogue, Errata, and therein occur: "Lot 140 for *Ventricosa* read *inflata*" and "Lot 285 for *obtusa* read *ventricosa*." On p. 12 is written, "Lot 140, *Phasianella ventricosa* Swainson, a beautiful variety of this new species, see Appendix" and p. 19, "Lot 285, *Phasianella obtusa* Sw., (see Appendix) from N.S. Wales, large" and on p. 55, "Lot 967, scarce variety of *Phasianella ventricosa* Sw. (see Appendix). New Holland." The Appendix is separately paged, and on p. 15 *Phasianella ventricosa*, Lots 285 and 967, is described, and on p. 16 *Phasianella inflata*, Lot 140, is also characterised. Both these descriptions apply, and the locality New South Wales may mean Victoria, as at that time the latter was not separated and all eastern Australia was known as New South Wales. *As the Sale of Bligh's Collection took place on May 20 to 26 inclusive in the* year 1822, the Catalogue was published prior to May 20, 1822.

In connection with the Phasianellids sent by Roy Bell from Port Fairy and Mallacoota, Vic., and Twofold Bay, N.S.W., I had to refer to the Man. Conch. (Tryon), and here give some notes taken in this connection. The Phasianellids were monographed by Pilsbry in Vol. x., pt. 2 (recd. B.M., 18 July, 1888), and he gave details of the radulae: on p. 163 he described the peculiar radula of the type species (of *Tricolia*) *P. speciosa* and then introduced *Orthomesus*, noting that the typical species was *P. variegata*, and adding "In *P. virgo* Angas (Pl. 60, fig. 70) I have found an extremely peculiar and interesting modification of the *Orthomesus* type of dentition." On p. 179, he formally named "Subgenus *Orthomesus*. Shell and operculum similar to *Phasianella*: radula with the central tooth reduced to a minute rudiment or absent. Type, *P. variegata* Lam."

However, as the range of *P. variegata* he gave "Zanzibar, Red Sea, New Caledonia, Mauritius, etc.," and cited numerous synonyms, concluding with "and *P. rubens* Lam. The latter I cannot identify; but, judging from Philippi's description and figure (Pl. 39a, figs. 6-7), of what he supposes to be Lamarck's species, and from Kiener's (Pl. 38, figs. 47, 48) I would place it in the synonymy of *P. variegata.* Philippi gives Australia as the locality of *P. rubens.*" Such treatment is difficult to understand in view of the facts. *Phasianella rubens* was described by Lamarck in the Hist. Anim. s. Vert., Vol. vii., pt. i., 1822, p. 53, from "Nouvelle Hollande; coll. by Peron," and a figure cited "Encylop., Pl. 119, f. 2a, b." The description is succeeded by that of *P. variegata,* where no figure is cited, and agrees with the shell known by the latter name. A List explanatory to the Encylop. plates was published in 1816, but no specific name was given to the figure cited. While the Twofold Bay shells seem to be a form of *ventricosa,* I collected at Caloundra, Queensland, commonly, a form which agrees more closely with *rubens,* and this should occur in Northern New South Wales, probably as far south as Sydney. I have noted that there appears to be geographical variation when these shells are examined in numbers. A form, like *variegata,* occurred at Port Fairy, Vic., which agreed with Crosse's *P. angasi* from South Australia, and this reached as far east as Mallacoota, but I did not get any from New South Wales, though it may occur there.

Hedley has placed this genus in the Family Turbinidae, but from the radular characters it deserves family rank, and perhaps later many genera may be recognised.

The shells found on the Sydney beaches, I find to differ a little from the Caloundra ones, and to agree closely with the typical *rubens,* while true Lamarckian *variegata,* judging from the figures given by Delessert (Recueil Coquilles

Lamarck, 1841, Pl. 37, figs. 10a-b) is a slenderer form like Crosse's *angasi* (Journ. de Conch., 1864, p. 344, Pl. xiii., fig. 5) and Lamarck's name is used in this sense in May's Illus. Index Tasm. Shells, 1923, Pl. xx., f. 5, and Check List Moll. Tasm., 1922, p. 41.

Shells from Twofold Bay are *ventricosa,* and the species reaches as far north as the Sydney beaches. As an item of interest this species (*ventricosa*) was irregularly named by Perry, as when he figured *Bulimus phasianus* (Conchology, 1811, Pl. xxx.), he observed "There is also a smaller species of the *Bulimus phasianus,* the pattern or marks of which are exactly similar to the one here represented, though its shell is rather thicker: it may therefore be denominated the *Bulimus phasianus minimus* of the before-mentioned genus." This name is not acceptable, but the solidity of the shell indicates the species here discussed.

When Pilsbry introduced *Orthomesus,* he figured, as the radula of *P. australis,* that given by Eberhard, noting it required confirmation. Claude Torr (Trans. Roy. Soc. S. Aust., xxxviii., 1914, p. 364, Pl. xix., figs. 5a-b) has since figured a radula from *P. australis,* noting the formula as ∞, 5, 1, 5, ∞ x 38, explaining that the central tooth was narrow and inconspicuous. This was annoying, as suggesting that Pilsbry's *Orthomesus* must be regarded as an absolute synonym of *Phasianella,* but did not explain Eberhard's figure of a large broad rhachidian tooth. This indicates that *P. ventricosa* of this note is the aberrant form, which conchologically it is, and in order to renew interest, I propose for it the new sub-generic name *Mimelenchus,* noting Quoy and Gaimard's expression as typical.

The fact that the radula of *Tricolia* differs so much from true *Phasianella* has been overlooked, and the recognition of a radula like that of *Orthomesus* i.e. *Phasianella* (*sensu stricto*), in *P. virgo* Angas shows that the small Australian Phasianellae have no direct relationship with the European *Tricolia,* of which the correct name would be *Eutropia* Humphrey, the only recognisable species included by Humphrey being the European *Turbo pullus* Linné.

(444) Astraea fimbriata Lamarck, 1822.

The two species distinguished by Kesteven (These Proc., xxvii., 1902, p. 2) occurred, and both the names used by Kesteven and listed by Hedley must be amended. Their nomination is somewhat complex and the conclusions must be carefully considered. Both species occur in Victoria and northern Tasmania, and are represented in Western Australia, these representatives being named many times, but apparently few names being given to the eastern shells. Gatliff and Gabriel, and May both use the above name, but unfortunately Lamarck's specific name, while it also probably is Western Australian, was used before by Borson.

The generally-accepted synonym, *Trochus squamiferus* Koch, published by Philippi, was given to a Western Australian shell, and of three others sometimes cited in this connection, *Trochus pileolum* Reeve, *Trochus limbiferus* Kiener, and *Trochus cucullatus* Kiener, none is applicable to the common Sydney shell. I propose to name this *Bellastraea kesteveni,* citing it as type of *Bellastraea,* as the species is not typical *Astraea,* and has no generic name.

For the other species Kesteven used the name *tentoriiformis* Jonas, but Hedley has recently rejected this on account of its Western Australian origin, and has preferred Gould's name *Turbo* (*Stella*) *sirius,* given to a Sydney specimen, collected by W. Stimpson. I would at present include it in the genus *Bellastraea,* the early development showing discrepancy which may necessitate a readjustment.

Quoy and Gaimard differentiated the two species as varieties only, figuring both under Lamarck's name of *fimbriatus,* and Philippi (Conch. Cab. (Kuster)

Vol. ii., Trochus, p. 215, 1852, Pl. 32, fig. 4) reproduced Quoy's figure of his variety and distinguished it as *T. urvillei.* Quoy and Gaimard figured an animal from Port Jackson, and others, including shells from King George Sound, W.A. Kiener (Coquilles Vivants, Trochus, Pl. 31, f. 2) reproduced Quoy's figure of the above-mentioned variety under Quoy's MSS. name of *Trochus georgianus,* thereby indicating the locality. Consequently *Trochus urvillei* Philippi, and *T. georgianus* (Quoy) Kiener, must be classed as synonymous of *T. tentoriiformis* Jonas, even as Fischer in the text of the Coquilles Vivants (p. 41, 1875) placed *georgianus.*

(448) TEINOSTOMA STARKEYAE Hedley, 1899.

This species seems no close relation to the genus *Teinostoma,* which was first published by H. and A. Adams in the Genera of Recent Mollusca, Vol. i., Aug., 1853, p. 122, and the example given *T. politum.* This has commonly been regarded as type, and is here definitely so designated, since it was the monotype at the later publication at the quotation given by Hedley. I propose to introduce the new name *Stipator* and name the species *T. starkeyae* as type. It does not seem at all wise to attach these Austral species to a name provided by Dall for American fossils, which, moreover, do not recall, to my eyes, the Australian shells.

Moreover, peculiar Teinostomoid shells do occur in this region, and Chapman and Gabriel have described a fossil as *Teinostoma depressulum,* which, while not typical, has many of the peculiar features of the true *Teinostoma,* while Tate's *Ethalia cancellata* is also of a peculiar style, and specimens of this, or a very closely allied, species are not uncommon in shell-sand round Sydney.

(463) LODDERIA MINIMA (Ten.-Woods, 1878).

This species, proposed under *Liotia,* has been transferred to *Lodderia,* but it should be separated as a distinct genus with the name *Lodderena,* with this species as type. I propose this, as I have recognised the form, specifically distinct, from distant localities and it seems quite peculiar. I also believe that under this specific name more than one species in Australia is already referred to, as until actual comparison was made, my discoveries were regarded as conspecific, and the same remark applies to *Lodderia lodderae* and *Liotia micans.* In the latter case I have proved by actual comparison that the Port Curtis shell is quite different from the Mallacoota one, though both had been lumped by Tate, after examination; another case of generic relationship being mistaken for specific identity.

(480-484) Family ACMAEIDAE.

Roy Bell sent me a magnificent series of these things, well collected and with full data, from every locality. I worked these out very carefully in connection with the British Museum types and literature, and made many notes for future research in the field. I am now taking my own advice, so here only deal with the facts I collated. I have incorporated some of my results, and may here note that the distribution of species in this family needs careful consideration, and that my results have been checked at different localities within and without the Harbour, and with attention paid to the station of life these forms adopt. When hundreds are critically examined the individual variation can be grasped and the geographical variation can be determined. Local variation also occurs, as well as environmental, and all these factors have been considered in the notes here following.

(480) PATELLOIDA ALTICOSTATA (Angas, 1865).

The type locality of Angas's species is Port Lincoln, S. Aust. Accepting the Port Fairy series as being nearly typical shells, the New South Wales form seems separable, the former agreeing very closely with the type shell still preserved in the British Museum. A very large specimen taken at Port Fairy is very tall and with the ribs flattened so that the edge is smoothish, and measures 57 mm. long by 47 mm. broad and 25 mm. high. Verco has given full details of this South Australian shell, which begins as a somewhat flattened, nine-pointed, acutely ribbed shell, and intercalating ribs begin behind the apex. All the Peronian shells I have examined from Sydney Harbour and Twofold Bay, N.S.W., Mallacoota, Lakes Entrance and Melbourne Heads, Vic., are much smaller, the ribs more regular and less prominent and for the same size more elevated. In order to draw attention to this item, I propose to name the Peronian form *Patelloida alticostata antelia* nov.

Maplestone (Monthly Micros. Journal, 1 Aug., 1872) has given (on Pl. xxvii.) under "Patella, No. 25." a good figure of the peculiar radula form of this species.

Since the preceding was written, I have carefully studied this species on the Sydney beaches, and find that the variation is much greater than anticipated from museum study, but that the factors above indicated exist in an intensified state; moreover, that the species is developing two forms, at times very different and even apparently specifically distinct. This smooth form lives *below* low water, and is flattened, the ribs obsolescent, and it is now breeding true to the specialised characters, series being collected from young to old, quite constant. I have as yet seen nothing like this form from any southern locality so I name it *Patelloida alticostata complanata* n. subsp. This smooth form is not uncommon as a dead shell, but has been dismissed as a worn form, whereas it is naturally smooth.

(481) PATELLOIDA MIXTA (Reeve, 1855).

When Hedley recommended the use of this name he did not discuss the forms, but apparently admitted the distinction of *mixta* and *crucis*, though not including the latter in the N.S.W. List.

The name was preferred, as Hedley suggested the rejection of Quoy and Gaimard's *Patelloida flammea* on the ground that it was a mixture. Unfortunately, I cannot agree as, though Quoy and Gaimard figured two species, their statement, "Il habite en abondance sur le bord de la mer, dans la rade de Hobart-Town, à Van-Diémen. Nous le trouvâmes *aussi* sur l'ille (sic) de Guam, dans l'Archipel des Mariannes," indicates the selection of the Tasmanian shell as being the correct course. The sentence "tenuissime longitrorsum striata" seems to distinguish the Tasmanian shell, which I conclude has little, if any, affinity with *mixta* Reeve, and I note Verco's most recent conclusion, "A form like the type (of *flammea*) which I have from the Derwent estuary, the type locality, has not been found by me in South Australia. It is questionable whether this is really conspecific with *A. jacksoniensis* Reeve and *A. crucis* Tenison-Woods." I have regarded Quoy and Gaimard's *flammea* (from the description and figures and excellent series given me by Mr. W. L. May, who has retained the name in his Check List and Ill. Index Tasm. Shells) as the eastern representative of Quoy's own *septiformis* and it occurs as far north as Sydney Harbour. Reeve's *mixta* was described from Port Phillip, Vic., and Bell sent me a fine series from Port Fairy, but none from Twofold Bay, N.S.W. I collected, in Port Phillip, a good

lot of these, as I found they lived almost at high tide (where *petterdi* does at Sydney). Mr. W. L. May stated that the Tasmanian shell he called *mixta* had the same habit. Reeve's *jacksoniensis* is a different form of the same shell, and several sets were in the British Museum from Sydney Harbour, but I could not find it on the Sydney beaches. This perplexed me, until I found it commonly, well inside the Harbour on the dead shells and stones in the Mangrove zone. Although often confused with the *crucis* form, it has a distinct habit and belongs to a different group, and I propose to distinguish the Sydney form (Reeve's *jacksoniensis*, preoccupied) as *Notoacmea mixta mimula*, n. subsp.

(482) PATELLOIDA MUFRIA (Hedley, 1915).

This peculiar little species was recognised as dead shells from shell-sand from Twofold Bay. I have since collected it commonly on the Sydney beaches, and regard it as a specialised derivative of the *crucis* series, and therefore referable to *Radiacmea*.

(482 A) RADIACMEA INSIGNIS (Menke, 1843).

In These Proc. (xxxix., 1914 (26 Feb., 1915), p. 712), Hedley suggested the usage of *Acmaea inradiata* (Reeve, 1855, *Patella*) in place of *Acmaea crucis* Ten.-Woods, quoting my letter as to their identity. Unfortunately, closer examination of the (reputed) type tablet failed to recognise any of the three shells thereon, which proved to have been added at various times, as the specimen figured by Reeve, though two were typical *crucis*, and the third aberrant. Consequently *inradiata* must be rejected from this fauna. Menke's *Patella insignis* (Moll. Nov. Holl. Spec., 1843, p. 34) from Western Australia is undoubtedly the Western Australian representative of *crucis*, shells from Busselton and Albany agreeing with Menke's description, as amplified in the Zeitschr. für Malak., 10 Apr., 1844, p. 62. This species lives in Victoria, Tasmania and New South Wales, under different forms, at extreme low water on the rocks and in pools, and at Long Reef, near Manly, N.S.W., commonly on *Turbo stamineus* Martyn, living below low water. The southern Tasmanian form is very large and conical, while the N.S.W. form is small and less elevated. When adult, the sculpture is not easily seen, but dead shells and young living ones show it to be a *Radiacmea*, and I name the Sydney form *Radiacmea insignis cavilla*, n. subsp.

(483) PATELLOIDA PETTERDI (Ten.-Woods, 1877).

I find this to be the universal rock-living species on the Sydney beaches, living high up above high water, and thus representing the Neozelanic *P. pileopsis* Quoy and Gaimard, which it closely resembles. I collected it at Caloundra, Q'land, and Roy Bell found it at Mallacoota and Lakes Entrance, Vic., and it must therefore be added to the Victorian List, as it is not conspecific with *P. septiformis* Quoy and Gaim. Roy Bell found at Port Fairy, Vic., a fine lot of the shell May has published (Illus. Index Tasm. Shells, 1923, Appendix to Pl. xxii., No. 3) with my name *mayi*. These species are *Notoacmea*, not *Patelloida*.

(483 A) NOTOACMEA FLAMMEA (Quoy and Gaimard, 1835).

As noted above, I regard this name as undoubtedly applicable to the species May has figured (Illustr. Index Tasm. Shells, 1923, Pl. xxii., f. 6) under this name. A very fine series was sent from Port Fairy, Vic., and these were determined from comparison with the types as *scabrilirata* Angas (Proc. Zool. Soc.

Lond., 1865, p. 154: Port Lincoln, South Australia), and this name may be later varietally used. Mr. W. L. May has given me specimens very similar that he collected at King Island. The juvenile of *P. septiformis* Quoy and Gaimard from King George Sound, W. Aust., is very similar, but the adult is very different. Hedley has suggested (These Proc., xlviii., 1923, p. 309) that Menke's *P. onychitis* (Moll. Nov. Holl. Spec., 1843, p. 34) may be a synonym of *septiformis,* both being from Western Australia. *N. flammea* lives *under* stones near high water mark, and I have collected it at Port Fairy, Port Phillip, Western Port, Vic., and on the Sydney beaches; the Sydney form being smaller and more oval, may be called *Notoacmea flammea diminuta,* n. subsp.

(484) PATELLOIDA SUBUNDULATA (Angas, 1865).

This species was not recognised in the collection, but as Hedley included it in the N.S.W. List, though described from South Australia, I re-examined the types in the British Museum. I found two different sets, both labelled types, but noted they were all presented as one lot. In the description Angas referred to a "var." One shell has been separated as the specimen described and labelled type, and the others representing the "var," unfortunately also labelled type, thus misleading investigators. Two shells are in this second box, and one may be a *conoidea,* the other a *calamus.* Mr. Hedley tells me he left this species on the N.S.W. List on Angas's inclusion, but has not been able to verify it.

May (Illustr. Index Tasm. Shells, 1923, Pl. xxii., f. 11) has figured *conoidea* under the name *subundulata,* and his *P. conoidea* (Pl. xxii., f. 4) seems to be an unnamed species.

(484 A) RADIACMEA CALAMUS (Crosse and Fischer, 1864).

Patella calamus Crosse and Fischer, Journ. de Conch., xii., 1864, p. 348: St. Vincent's Gulf, S. Aust.

Dead shells were sorted out of shallow water dredgings from Twofold Bay, N.S.W., which were referable to this species, though varying a little from the type and may later show a recognisable variant.

(484 B) PATELLOIDA SUBMARMORATA (Pilsbry, 1891).

Acmaea marmorata var. *submarmorata* Pilsbry, Manual Conch., Ser. ii., Vol. xiii., 1891, p. 52, Pl. 42, figs. 69-70: Port Jackson.

This species was accidentally omitted by Hedley from his N.S.W. List, as it is a common and well-known Sydney shell, living about high water mark just below *P. petterdi.* It is well differentiated from the southern forms and ranges into Victoria at Mallacoota. Bell's series from Port Fairy were so instructive that I investigated the nomination of the species with his shells in hand. These showed two forms from the same locality, one living at medium tide, the other below low water, the former higher and more irregular, the latter flattened and regularly starlike. May states of *marmorata,* "common near highwater mark, much eroded," but does not show altitude, only internal view, in his Illustr. Index Tasm. Shells, Pl. xxii., f. 9. Pritchard and Gatliff used the specific name *gealei* Angas, citing *latistrigata* Angas and *marmorata* Ten.-Woods as synonyms. Verco, from examination of the British Museum types, rejected *gealei* as referable to a distinct species, but admitted *latistrigata* Angas was apparently only a smoothish form of *marmorata* Ten.-Woods, but used the latter name. Pritchard

and Gatliff accepted this correction, but pointed out that *latistrigata* had priority. I searched for the types in the British Museum, and found those of *latistrigata* and *gealei*. Of the latter, Verco had concluded "The two type shells are 24 mm. x 21. I think they are large albino variants of *A. crucis* Ten.-Woods." I had great difficulty in tracing these types in the British Museum, but at last found them among the Patellidae, as one was a *Patella*, the other specimen an *Acmaea*. Though these were in the same box, they had been presented at different times, the larger one, the *Patella* being registered 70.10.26.155. This means the 155th set registered on the 26th of October, 1870, and the register showed that here was included all Angas's type shells presented by him, but none stated to be types. Reference to the original description of *P. gealei* (Proc. Zool. Soc. Lond., 1865, p. 57) gave details "sed pagina interna metallice splendente, aureo parum tincta, margine minimo; spathula lurida, plumbeo et fusco nebulosa. Long .1 (error for 1): lat. .86: alt. .4 poll." The *Patella* agreed in these items, but not the *Acmaea*, which is smaller, narrower and taller. The latter was registered 77.5.12.63, when Angas presented another series, including new species described since the previous gift. The *Acmaea* was marked "type" some years later in error, and then placed in the box with the real type. It was intended by Angas as an additional specimen of the rare species previously described. The *Patella* is very much corroded externally, but the edges show the regular ribbing of the *Patella* rather well: the inside is "splendidly shining" as it is a diseased specimen, and the shining effect is due to the deposition of extra enamel internally to prevent the external corrosion eating through. The *Acmaea* was regarded as conspecific (probably from memory only) by Angas from a similar cause, a fracture causing the animal to enamel internally in the same manner. The *Acmaea* is undoubtedly a *crucis* shell, but the *Patella*, which is the *sole* type of *P. gealei*, is a small diseased specimen of the South Australian *variegata* or *limbata*, it is impossible to determine which, if there be two species, as Verco concludes. The New South Wales members of the Acmaeidae would now be

480 *Patelloida alticostata antelia* Iredale
  A *Patelloida alticostata complanata* Iredale
481 *Notoacmea mixta mimula* Iredale
482 *Radiacmea mufria* (Hedley)
  A *Radiacmea insignis cavilla* Iredale
483 *Notoacmea petterdi* (Ten.-Woods)
  A *Notoacmea flammea diminuta* Iredale
484 *Patelloida subundulata* (Angas)
  A *Radiacmea calamus* (Crosse and Fischer)
  B *Patelloida submarmorata* (Pilsbry)

Two corrections to be made in connection with Neozelanic species may be here added. Searching for these Australian types I came across (in the British Museum) a tablet bearing a small shell bearing the name "*Patella inconspicua* Gray, New Zealand, Dr. Stanger" in Dr. J. E. Gray's handwriting, and the register number 42.11.16.92; added by E. A. Smith was "Dieffenbach n. 123." Reference to Dieffenbach (p. 244) gave the description of n. 123. "Shell conical, oblong, with about 20 radiating ribs, the apex erect, disk white, rather greenish under the tip, length 1½ inch." Such as it is, this description agreed with the shell on the tablet save in size, the length being ½ inch, not 1½, as written: such an error is common in connection with Gray's work. The species described is the one later called *Fissurella rubiginosa* by Hutton, and the type probably came from the Bay of Islands, a locality mentioned by Suter for this species,

which must now be catalogued as *Radiacmea inconspicua* (Gray). The shell described by Suter (Manual New Zeal. Moll., 1913, p. 81) under the name *Helcioniscus ornatus* Dillwyn subsp. *inconspicuus* Gray scarcely seems worth distinguishing, but this matter must be determined by Neozelanic conchologists on the spot.

The second item is the more pleasing reinstatement of the name *fragilis* for the peculiar little species so named by Chemnitz, whose name I was compelled to reject, since Chemnitz was not a binomial writer. At the time I wrote my Commentary on Suter's Manual, I could not trace, even with the help of Sherborn's MSS. for the second part of his Index Animalium, now happily in progress of publication, a use by a binomial worker of Chemnitz's name prior to the proposal by Lesson of his species *P. unguis-almae*. I now record that *Patella fragilis* was legitimately used by Sowerby in the Genera Recent and Fossil Shells, Part 21, Pl. 140, f. 6 and text in 1823, so that we can revert to the specific name so well known, the species being now referred to as *Atalacmea fragilis* (Sowerby).

(485-488) Family PATELLIDAE.

The most remarkable distinction between the Adelaidean and Peronian Regions is seen in the presence of the genus *Stenochiton*, of the Order Loricata, and of the genus *Nacella*, of the present family, in the former Region, in each case more than one species having evolved, while no trace of either has been found in the latter. In order to attract more attention to this item, I here introduce the new generic name *Naccula*, naming *Nacella parva* Angas = *Patelloida punctata* Quoy and Gaimard as type. This species has so little resemblance to *Nacella*, that, when it was first received in Britain some eighty years ago, it so puzzled the industrious shell-namers of that period that they did not name it at all, the specimens being still unnamed in the British Museum. The earliest name, as above given, was bestowed by Quoy and Gaimard (Voy. de l'Astrol., Zool. Vol. iii., 1835, p. 365, Pl. 71, f. 40-42) from King George Sound, W.A., a determination hitherto neglected.

(485) PATELLA PERPLEXA (Pilsbry, 1891).

Dealing with Neozelanic shells, I was able to rectify the specific designation of the shell previously known as *Acmaea octoradiata* Hutton, and from shell characters referred it to *Patelloida*. Hedley, in his N.S.W. List, differed, concluding it to belong to *Patella*, and, as the subdivisions of that family are imperfectly known, merely classed it under *Patella*. Roy Bell sent me a number of dead shells, but also a few live ones procured at a very low tide, and one of these showed the dried up animal, which proved to be of *Patelloid* facies. From this the radula was extracted for me by my friend Lt.-Col. Peile, and upon examination it was seen to be very near those of *P. aculeata* and *P. ustulata*, as figured by Claude Torr (Trans. Roy. Soc. S. Aust., xxxviii., 1914, p. 365, Pl. xx., figs. 3 and 2). C. Torr notes that the latter has only one marginal, and that *P. vulgata* L. has no central tooth, while *P. cretacea*, as figured by Cooke, has a central tooth but only two marginals. Upon this evidence I much doubt the occurrence of this species in New Zealand, and suggest reconsideration. I have since examined specimens from N.Z., which proved to be immature *Patelloida stella* Lesson. Some small dead shells from Mallacoota, Vic., and some from shallow water dredgings in Twofold Bay, N.S.W., were attributed by me to *Patella chapmani*, but later I recognised that they were the young of the present species. The description of *Patella chapmani* Ten.-Woods (Papers Proc. Roy. Soc. Tasm.,

1875 (1876), p. 157) applies very well to this species and suggests reconsideration of the specific name. Certainly my shells agree closely with the description of *P. chapmani*, as they are as certainly Pilsbry's *P. perplexa*, in which case Tenison-Woods's name claims usage.

The radular formula is 3.1.2.1.2.1.3: the central tooth is small while the huge lateral appears to have four cusps, the three marginals rather delicate. In examining these radulae, I was impressed by the futility of the radular formula in indicating relationship, as another radula giving exactly the same formula was absolutely different owing to the different setting of the teeth: in some cases, almost a straight line was seen, in others almost a semicircle, and consequently the number of rows in the same length was very different, though the total number of rows might be the same (since figured by Peile, Proc. Malac. Soc. Lond., xv., 1922, p. 17, Pl., fig. 4). The preceding was written in England, and I have since carefully studied the species with interesting results. Dead shells, mainly very regular *octoradiata*, abound on the Sydney beaches, so that they must be very plentiful below low water mark; consequently I made special search and collected alive a fair number with the result that those on the surf-beaten rocks were very flat, eight-ridged *octoradiata*, while those at all sheltered by an intervening boulder were taller, still eight-ribbed, but ribs not so prominent. This at once confirmed the suggestion that *chapmani* was the same shell, with the additional information received from Mr. W. L. May that *chapmani* was the common form in southern and eastern Tasmania and *octoradiata* was very rare, even if typically found there. He pointed out that *Acmaea alba* Tenison-Woods was also a synonym. This was described (Proc. Roy. Soc. Tasm., 1876 (1877), p. 155) from northern Tasmania, and I found in the Australian Museum a specimen marked "Author's type." At first sight, this seemed very different, being a high rounded, regularly ribbed shell with about fourteen sharp ribs intercalated with smaller ribs and riblets; it has been cleaned up so that the juvenile shell appears to show nine or ten primary ribs or bunches. The locality is confirmed by a set of three with data in Miss Lodder's handwriting "*Acmaea saccharina* L. (Plentiful on) N. Coast Tas." One shell agrees very closely with type, the second is a little less circular and a little taller but otherwise similar, while the third is a small shell of the *chapmani* style, showing eight primary ribs with four a little weaker.

My conclusions are that the specific name must be *chapmani*, but that the Adelaidean form may bear the varietal (subspecific) name of *alba*, and the Peronian form may be called *P. chapmani perplexa*.

Pilsbry (Man. Conch., Vol. xi., 1889, p. 54, Pl. 42, figs. 76, 77, 78) has given excellent figures of a specimen of *Acmaea alba* Ten.-Woods, noting that the description given by Tenison-Woods did not seem applicable to the shell figured. Chapman and Gabriel (Proc. Roy. Soc. Vict., xxxvi. (n.s.), Dec., 1923. p. 24) have described *Patelloida hamiltonensis*, while recording *P. perplexa* in a fossil state: these should be compared with a series.

(486) Patella squamifera Reeve, 1855.

The type of *Patella* is undoubtedly *vulgata* L., and, when the common *Helcioniscus* of New South Wales was first described, it was independently compared by two workers with the common European species, as already recorded by Hedley. Consequently the reference of a very different shell to *Patella* does not seem a logical conclusion. In view of this, it will be useful to have a name for these aberrant forms, so I propose the new generic name *Patellanax*, with

P. squamifera Reeve as type. Some years ago Mr. Hedley, in correspondence, suggested a relationship with the large *Patella*, i.e., "*Ancistromesus*" *kermadecensis*, from the Kermadec Group. Previous to that communication, I had attempted to account for the presence of that large species on that isolated group, and concluded that it was an outlier of the *cretacea* group. The series in the British Museum shows *Patella cretacea* Reeve (Conch. Icon., Dec., 1854, Pl. xxi., f. 53: Tahiti) which seems to be equivalent to *P. gigantea* Lesson (Voy. Coquille, Vol. ii., 1830, p. 423) from Borabora, Society Group; *Patella pentagona* (Born ?) Reeve (Conch. Icon., Dec., 1854, Pl. xx., sp. 48): Elizabeth I., South Seas; Palmerston I.: *Patella stellaeformis* (ibid.) which was described first in the Conch. Syst., Vol. ii., 1842, p. 15, Pl. cxxxvi., f. 3, from unknown locality: *P. pica* Reeve (Conch. Icon., Dec., 1854, Pl. 19, sp. 45): South Seas. All these are closely related to the Kermadec shell, and small specimens of the latter collected by J. Macgillivray were labelled *pica* fifty years ago. The series of *pentagona* from Palmerston Island shows the growth from a small regular eight-pointed shell like *Patella perplexa* into a semi-oval comparatively smooth-edged adult. I secured similar shells showing growth stages of the Kermadec species, and it is peculiarly interesting to find *Patella perplexa* (see preceding note) showing this evolution in the shell in an arrested stage, yet with a similar radula, while, if Claude Torr's observations on the radula of *ustulata* be confirmed, we have also a very peculiar modification in this feature with the shell characters little altered. In Proc. Roy. Soc. Vict., xv., n.s., pt. ii., Feb., 1903, Pritchard and Gatliff allowed *Patella ustulata* (p. 193), *Patella aculeata* (p. 193), *P. chapmani* (p. 193), and then proposed (p. 194) *Patella hepatica* P. and G. nom. mut. for *Acmaea striata* Pilsbry (non Quoy and Gaimard) Man. Conch., Vol. xiii., 1891, p. 47, Pl. 35, f. 27, 28, 29." As no description was given, Pritchard and Gatliff's name can only be construed as alternative for Pilsbry's identification, *which is of a Celebes shell,* and, consequently, has no place in South Australian literature. Verco recorded *hepatica* from South Australia, but surmised that it might only be a variant of *ustulata,* which he was also inclined to associate as conspecific with *aculeata.* Claude Torr has published accounts of the radulae of *ustulata* and *aculeata,* which proclaim these as very distinct species. My series, sent from Port Fairy, Vic., showed them as quite distinct forms, the *aculeata* living higher up, and the *ustulata* practically below low tide. I did not receive any shells which I could refer to *hepatica* and from Lakes Entrance and Mallacoota all the shells sent were *aculeata,* as were all the Twofold Bay specimens. From Tellaburga Island, live *aculeata* of large size, quite abnormal, were also sent, but dead shells were either *ustulata* or *hepatica,* and the latter looked very distinct. Since the preceding was written, Gatliff and Gabriel have renamed (Proc. Roy. Soc. Vict., xxxiv., n.s., May, 1922, p. 152) *hepatica,* which they have called *victoriae,* as they noted the name was preoccupied by Gmelin, but still their name has no standing. Verco has suggested that this un-named, yet multi-named, form may be an extreme variant, but in view of Claude Torr's differentiation of the radulae of *ustulata* and *aculeata,* no certainty can be considered until the radula of *hepatica* is determined.

Again, local collecting has furnished interesting results, as at Port Fairy I found a couple of worn dead shells of the *hepatica* form, while continued search on the Sydney beaches has failed to reveal anything save *aculeata.* In southern Tasmania the predominant species appears to be *ustulata,* though *aculeata* also occurs. This form was named *P. tasmanica* by Tenison-Woods (Proc. Roy. Soc. Tasm., 1875 (1876), p. 157) who, the succeeding year, withdrew his name in

favour of Reeve's *ustulata* (id., 1876 (1877), p. 49), giving an excellent account of shell, animal, habits and radular characters, citing two laterals. Philippi's *Patella diemensis* (Zeitschr. für Malak. (Menke), 1848 (Mar., 1849), p. 162) from Hobart, Tas., which Pritchard and Gatliff once proposed to use instead of the incorrect name *tramoserica*, appears to be referable here, as the words, "albida, sulcis frequentibus circa 54, fuscis exarata. *intus alba;* margine crenulato, intus ad crenas puncto fusco notato," apply to some variations of the present species, but are never applicable to *tramoserica*. An earlier name given to the Western Australian shell appears to be *Patella perônii* Blainville (Dict. Sci. Nat. (Levrault), Vol. xxxviii., 1825, p. 111) from King George Sound, but which may be the southern Tasmanian shell. At this place Blainville definitely described six species from Australia, one of which, *Patella variegata* (p. 101, from Botany Bay), has been accepted for the Sydney *Helcioniscus*. The other names are *P. conica* (p. 107) from Maria I., Tas., *P. solida* (p. 110), *P. rubraurantiaca* (p. 110), and *P. laticostata* (p. 111) from New Holland without definite locality. The description of *P. conica* does not agree well with any shell from Maria Island, and it is here suggested that it may be the *Patella gigantea* named, but not described, by Peron (Voy. decouv. Terres Australes, Vol. i., 1807, p. 120) from Bernier's Island, but no specimens are available from that locality for comparison. *Patella solida* appears to have been collected in southern Tasmania, as the description agrees with the species commonly called *limbata*. Mr. Hedley had independently arrived at this conclusion, and there are specimens in the Australian Museum agreeing exactly with Blainville's account. *Patella rubraurantiaca* was given to the South Australian shell known as *P. limbata*, the description applying accurately to specimens in the Australian Museum collected at St. Francis Island, Nuyts' Archipelago, by Sir J. Verco, an island on which Peron himself collected. *Patella laticostata* was given to shells, collected by Peron and Lesueur at King George Sound, and these would undoubtedly belong to the species, later named *Patella neglecta* by Gray, which name should be superseded. This accounts for the species localised by Blainville from New Holland, and also covers all the larger limpet-like shells, save *P. alticostata*, which may be among the large number described from unknown locality. Another curious factor is then explained as, when Quoy and Gaimard named all their new species of limpet-like shells, they confined themselves to the smaller species, the reason being that all the large ones already bore Blainville's names in the Paris Museum where they also worked.

To summarise:

Patella peronii Blainville, 1825 = *Patella diemensis* Philippi, 1849 = *Patella ustulata* Reeve, 1855 = *P. tasmanica* Ten.-Woods, 1875.

Patella variegata Blainville, 1825 = *P. tramosericus* auct.

Patella conica Blainville, 1825 may equal *P. gigantea* Peron, n.n., Bernier I., W.A.

Patella solida Blainville, 1825 = *P. limbata*, Philippi, 1849: East Tasmania.

Patella rubraurantiaca Blainville, 1825 = *P. limbata* so-called from South Australia.

Patella laticostata Blainville, 1825 = *P. neglecta* Gray, 1826.

(487) Cellana illibrata (Verco, 1906).

I have been quite unable to understand why Verco described this species as a *Helcioniscus*, as both the shell and radular characters differ appreciably. From the shallow water dredgings from Twofold Bay, I sorted out dead shells which I

regard as similar to those accepted by Hedley as Verco's species, but they do not exactly agree in being of less altitude and the apex less directly central. I have not been able to see the muscle scars in my specimens yet, so my identification may even be wrong.

I have sorted many specimens out of shell-sand from the Sydney beaches, and find that the muscle scars are Patelloid, and consequently the species might be better placed in *Parvacmea,* while the series is separable from Verco's species by their shape. Many are rose-rayed and recall May's figure of *N. suteri* (Illustr. Index Tasm. Shells, 1923, Pl. xxii., f. 12). May's shells may be the southern variant of the species here discussed, and for which I propose the name *Parvacmea illibrata mellila,* n. subsp.

(488) Cellana variegata (Blainville, 1825).

This species has long interested me and I desired good series to study the variation. I collected a few in Sydney Harbour and a fine lot at Caloundra, Q'land, and these showed little variability under normal conditions. Roy Bell sent me a magnificent lot of limpets from Lord Howe Island, as these had been regarded as the same as the Sydney species. They were obviously distinct and, moreover, two separable forms were received, living in different localities. From the British Museum Collection the form *limbata* seemed easily separable from my normal *variegatus,* so I wanted to study series, as there had been more than one view upon the subject. Tate and May called the Tasmanian shells *tramosericus,* citing *limbata* Phil. as an absolute synonym without any remarks, while in Pritchard and Gatliff's List, *Patella limbata* is also included as a distinct species from Cape Otway (G.B.P.) alone. Verco at first only included one form, but afterward added *P. limbata* stating "It has been taken at the Neptune's and Thistle Island, and in Spencer Gulf by Dr. Torr: on Yorke Peninsula by Matthews; at Encounter Bay by myself. I did not find it at Kingston, Robe, Beachport, or MacDonnell Bay," and later "It is very common, large and beautiful in St. Francis Island. I did not take it anywhere in Western Australia." Geographically, limpets from Port Fairy, Vic., might be *limbata.* A series sent by Roy Bell are very instructive; all are tall and at first sight two distinct sets can be separated, which are demonstrably conspecific. The first set are normal. of yellowish ground with black stripes, regular flattened ribs and the apex eroded; inside yellowish, the spatula varying from brown to pale cream, the edges marked with black: these came from sandstone rocks and some specimens approximated in their uniform orange colour inside and out to the *flava* variety of the Neozelanic *C. radians,* about which I have commented (Trans. N.Z. Inst., xlvii., 1914 (1915), p. 432-3). The second set are also tall, bluish-black above, with few or no lighter stripes, ribs pronounced and somewhat sharply cut, and very little erosion present: inside bluish, the spatula milky white from pale brown, edges scarcely marked with black: these came from black basalt rocks and correspond to the *perana* variety of the Neozelanic *C. radians.* I have compared these with the Peronian representative and conclude they are specifically identical, but, after allowing for individual variation, I find they are constant in their fewer ribs, comparatively taller and narrower, and the beaded ribs so noticeable in the typical juvenile are almost entirely missing. I propose to name the Port Fairy series *Cellana variegata ariel,* n. subsp., as I find *Patella limbata* was proposed by Bolten (Mus. Bolten, 1798, p. 1) years before Philippi used it. There are probably many synonyms of the typical *variegatus,* but, as far as I can trace, none from an Adelaidean locality.

A series of shells was sent from Mallacoota, which were all small and of the yellowish type, and from Tellaburga Island, a fine lot of very large shells, also of this type, much eroded; a few small shells from Melbourne Heads were similar. Very many smallish shells were received from Twofold Bay, which generally agreed in coloration. The Mallacoota, Tellaburga Island, Melbourne Heads and Twofold Bay shells, though varying slightly in each case, showed the features ascribed to the Peronian form as already given from Sydney and Caloundra specimens. Eastern Tasmanian shells all appear to differ, even reaching the Furneaux Group, whence May recorded (Vict. Nat., xxx., 10 July, 1913, p. 57) *Patella limbata* of huge size. The investigation of that Group has proved of great interest to the student of geographic zoology, as the Adelaidean forms commonly met there by May are generally missing from the Mallacoota collection, and, moreover, the Peronian species now traced down to Mallacoota do not appear to have yet reached the Furneaux Group. May, however, records *C. variegata* Bl. as "rare and small in Tasmania, East Coast," so that reconsideration is necessary, while I do not know what species occurs on the North Coast. *Cellana variegata* does *not* occur in Neozelanic waters, some form of *radians* having been mistaken for it, as I have previously suggested.

The subject requires study from the following viewpoints: *Cellana variegata* Bl. lives on the Peronian coast from Point Arkwright, a little north of Caloundra, Q'land down the east coast and round the corner to Melbourne Heads. According to locality and station, it shows a little variation in size, shape, form and colouring. Does it occur normally on the eastern Tasmanian Coast? What species occurs on the northern coast of Tasmania? The western Victorian shells are notably different in shape and a little in sculpture, and appear to constitute a recognisable race, which I have named *Cellana variegata ariel*. Does a form of this race occur in South Australian waters?

Cellana solida Blainville is the name for the eastern Tasmanian shell known as *limbata*, which appears to be a distinct species. *Cellana rubraurantiaca* Blainville is the name of the South Australian shell, known as *limbata*, and this may be a different species from the eastern Tasmanian *solida*. What species occurs in Victoria, that has been recorded as *limbata*, and what relation (if any) of this species lives in Western Australia?

(494) TECTARIUS PYRAMIDALIS (Quoy and Gaimard, 1833).

The figure given by Quoy and Gaimard is very poor, but the locality Jervis Bay, N.S.W., has allowed acceptance without argument.

Fifty years previously Chemnitz (Conch. Cab., Vol. v., 1781, p. 42, tab. 162, fig. 1545-46) had described "Der Kleinknotige Krausel," "ex Museo Spengleriano et nostro," received from Cook's trip to the South Seas which he figured, and mentioned a smaller form from the West Indies. For this species (a compound, but mainly Australian) Gmelin proposed the name *Trochus nodulosus* (Syst. Nat., Vol. i., 1791, pt. vi., p. 3582), giving as habitat "In Oceano australi et (*minor*) mari Americano meridionalem alluente," thus absolutely fixing his name to the Australian shell. Unfortunately, the name he selected had been previously used by Solander (Fossil Hanton, 1760, p. 10), and the same result befell Dillwyn's name *Turbo trochiformis* (Descr. Catal., pt. ii., 1817, p. 826), given to Chemnitz's figure with the locality restricted to South Seas, as Born (Index Mus. Caes. Vindob., 1778, p. 355) had anticipated the name selection. This would leave Quoy and Gaimard's name, but there is another complication. Menke (Verz.

Conch. Samml. Malsburg (pref. Mai 18) 1829, p. 10), introduced *Litorina tuberculata* for *Trochus nodulosus* Gmelin, and Menke's name seems acceptable. In his Synopsis, 2nd ed., published the succeeding year, Menke gave (p. 44) the same name to Gmelin's *Trochus nodulosus minor*, and the latter usage has been accepted, but is not correct.

Chemnitz's figures are excellent, and are probably painted from specimens collected by Captain Cook's companions at Botany Bay, N.S.W., where the species is easily procured at Cook's landing place even at the present time. In volume ix. of the Manual of Conchology, published in 1887, Tryon used (p. 258) *Tectarius nodulosus* ex Gmelin, to include the West Indian. Ceylon, Australian and New Zealand (where the genus does not occur) forms.

The name would then appear to be *Tectarius tuberculatus* (Menke, 1829) and the species ranges down to Mallacoota, Vic., and appears to be an addition to the Victorian List.

(508 A) LIRONOBA AUSTRALIS (Ten.-Woods, 1875).

The common Tasmanian shell known as *Rissoa tenisoni* Tate is here added to the New South Wales fauna. It was described as *Cingulina australis* by Tenison-Woods (Papers Proc. Roy. Soc. Tasm., 1875 (1876), p. 146) and the specific name was altered on account of its transference to *Rissoa*, in this case practically an unwarranted change, as it is less like the type of *Rissoa*, than it is like *Cingulina*. Upon its distinction as *Lironoba*, the original specific name must be reverted to.

(508 B) BOTELLUS BASSIANUS (Hedley, 1911).

Onoba bassiana Hedley, Zool. Results Endeavour, 1909-10, Part i., 22 Dec., 1911, p. 108, Pl. xix., fig. 25: Off Devonport, N. Tasmania.

When I introduced *Subonoba* (Trans. N.Z. Inst., xlvii., 1914 (12 July, 1915), p. 450), I wrote "Probably the shells classed by Hedley in *Onoba* viz. *Onoba bassiana* . . . . could be here placed, as, though it does not fairly agree in general shape and mouth characters, disagrees much more with typical *Onoba*."

A few specimens were received from the 50-70 fathoms off Green Cape, and from 25 fathoms in Twofold Bay, and I have no hesitation in introducing the new generic name *Botellus*, citing *O. bassiana* Hedley as type. The circular mouth separates this group widely from any other of the Austral Rissoid series. *Onoba glomerosa* Hedley from Queensland belongs here, but Watson's *mercurialis*, also from Queensland, appears to be a *Subonoba*.

(510) ATTENUATA MINUTULA (Tate and May, 1900).

This species is certainly not referable to this family. It is a very peculiar little form without any known close relations, and I do not consider Hedley's *Rissoa integella* congeneric. I first found it as dead shells in shell-sand from northern Tasmania, but I have found it alive in some dead-coral washings from 20-25 fathoms in Twofold Bay, and I now propose for it alone the new generic name *Coenaculum*. It is not rare in shell-sand on the Sydney beaches.

(521) ANABATHRON EMBLEMATICUM (Hedley, 1906).

This species, easily recognisable, was not uncommon, but was always small, so that I concluded the measurements given by Hedley might be incorrect, and this I find to be so, a mistransliteration having taken place. The correct size of the species is 2 mm. x 1 mm., not 4 x 2 mm. as given.

(536 A) Rissoina lintea Hedley and May, 1908.

Rissoina lintea Hedley and May, Rec. Austr. Mus., vii., 11 Sep., 1908, p. 117, Pl. xxiii., fig. 11: 100 F., off Cape Pillar, Tasmania.

Specimens were sorted out of the 50-70 fathom dredgings off Green Cape, another addition to the N.S.W. List.

(539 A) Heterorissoa wilfridi (Gatliff and Gabriel, 1911).

Jeffreysia wilfridi Gatliff and Gabriel, Proc. Roy. Soc. Vict., xxiv. (n.s.), 1911, p. 188, Pl. xlvi., fig. 3.

This adds a species and genus and probably a family to the N.S.W. List. The genus *Heterorissoa* was proposed by me (Proc. Malac. Soc. Lond., x., Oct., 1912, p. 221), with a Kermadec species, *H. secunda* (op. cit., fig. in text) as type, to include the (apparent) southern representatives conchologically of the northern *Jeffreysia*, which show a distinct difference in the opercular characters. Found in shallow water dredgings sent by Roy Bell from Twofold Bay. I find shells not uncommon in the shell-sand of the Sydney beaches.

(540 A) Stiva royana, n.sp. (Plate xxxiv., f. 11.)

A second member of the genus *Stiva*, of smaller size and more delicate sculpture, and with a typical operculum.

Shell awl-shaped, apex blunt, mouth ovate, slightly channelled anteriorly. Colour white marbled with orange, forming a subsutural band in many cases, the apical whorls uniform orange. The first two whorls are smooth, the succeeding one faintly longitudinally ribbed, the ribs growing stronger, the adult whorls numbering ten. The ribs number about thirty-two on the penultimate whorl, flexuous and narrow, the interstices being wider and latticed with very fine scratched lines: on the last whorl the ribs cease at the periphery and the basal sculpture consists of transverse scratches and obsolescent growth lines. The outer lip sharp but not thin, the inner lip continuous and appressed to the basal whorl, a minute umbilical chink sometimes appearing. Length 15.5 mm., breadth 6 mm.

Dredged in 10-25 fathoms, Twofold Bay; also in 10-15 fathoms, Disaster Bay; and also in 10-15 fathoms off Gabo Island, Victoria.

(561 A) Capulus australis (Lamarck, 1819).

Hedley has recently accepted *Capulus calyptra* Martyn for the Bass Straits *Capulus*, but this I think is erroneous, and I would recommend the name he previously determined for use, and add the species to the N.S.W. Fauna, as it has pushed round the corner and lives in Twofold Bay. Numerous specimens were sent from Port Fairy, where it is abundant on *Haliotis*, and then quite a few were received from Mallacoota and Tellaburga Island, and among these very many showed the apical whorls which were, as expected, always dextral. Some time ago, I examined all the *Capulus* and *Hipponyx* in the British Museum Collection and in my notes I find "*Capulus danieli* Crosse. Type from New Caledonia is not South Australian shell, but is *calyptra* Martyn." Specimens from Lord Howe Island are quite unlike southern Australian shells. As I have now plenty of good material I will reinvestigate the matter, and note the radular characters of these animals. Maplestone (Monthly Micros. Journal, 1 Aug., 1872, Pl. xxvi.) has figured the radula of a Victorian specimen.

(563 A) Plesiotrochus monachus (Crosse & Fisher, 1864).

It seems very doubtful that this is the correct generic location for this shell, which was described (Journ. de Conch., xii., 1864, p. 347) from Port Adelaide, S. Aust., and which I recovered from a dredging made in 10-20 fathoms off Merimbula, N.S.W., and odd broken dead shells from Twofold Bay. It appears to be an addition to the recorded N.S.W. fauna. While the radula and operculum of this species are known, those of the type of *Plesiotrochus*, a rather different-looking shell, are not, and as the latter is a tropical genus, whereas the present shell appears to be confined to the Adelaidean Region, outside the tropics, its transference is soon anticipated.

(566) Bittium granarium (Kiener, 1842).

Bittium has maintained its generic position because the animal showed a multispiral operculum with a central nucleus, in place of the normal Cerithioid paucispiral operculum. The Australian shells appeared exactly comparable with the European forms, but the operculum is paucispiral, and, consequently, once again an alien name must be dismissed, and the Australian shells that agree most closely with European ones prove to cover different animals.

More than one generic form has been lumped in the Austral *Bittium*, but I here propose only the new generic name *Cacozelia*, with the species *Cerithium lacertinum* Gould as type.

Hedley has, since this note was written, published the differential features that separate the Western Australian *granarium* from the eastern Australian *lacertinum* Gould.

(577) Seila turritelliformis (Angas, 1877).

Though Hedley synonymised with Angas's species, his own *Seila attenuata*, I have never been sure of this identity. Hedley's species was well known and represented a generic type for which I propose the new generic name *Seilarex*. Species closely agreeing in generic characters from South Africa, differ at sight from the *Seila* in shape, sculpture, form of mouth and texture of shell. Angas's picture did not show these particulars, and I have found, among some shells belonging to Mr. Hedley, specimens collected years ago by Brazier which are near Angas's figure, and seem to represent the latter's species. Therefore, I would add No. 577a *Seilarex attenuatus* Hedley 1900 (*Seila*).

Live shells have not yet been found, but their study will be interesting, as, in the Check List, *Seila* and *Cerithiopsis* are placed in Cerithiidae, and followed by the Triphoridae, whereas in connection with Palaearctic species these genera, from study of the animals, are widely separated, and it is possible that the Austral species entirely differ.

(591-600) Family TURRITELLIDAE.

Ten species are recorded, all under the genus name *Turritella*, though when Miss Donald wrote her essay she had provided two special names for some Austral forms, thus: *Colpospira* Donald (Proc. Malac. Soc. Lond., iv., pt. 2, Aug. 1900, p. 51: Type, by original designation, *Turritella runcinata* Watson, and (p. 53) *Platycolpus*, type, by original designation, *Turritella* (*Colpospira* ?) *quadrata*, n.sp. (Pl. v., fig. 8-8b), from Bass Straits, 45 F. In that essay only a few specimens were studied, but the results were good. I have received

thousands of specimens of many species from various depths. From these I would urge the recognition of the above names, as *Turritella* is widespread and of great antiquity, and none of the Australian species is closely related to the typical species. Moreover, I find that the Austral forms can be separated into distinct series so that more than one generic name is necessary.

Probably these things are rare, but otherwise they have been badly treated. Watson's determinations are particularly wretched, as he was really not a good conchologist, and his painstaking results are peculiarly unreliable. Hedley has pointed out that he named wretched fragments of juvenile specimens as novelties, and in the present group his results are amazing. I have just examined the whole of the Challenger material named by him, and find a dead shapeless item soberly named and allotted a number and registered as a molluscan specimen in the British Museum. This has often occurred, and little reliance can be placed upon any of his records, and many of his "new species" are scarcely recognisable. It would serve little good purpose to controvert all his identifications, one will suffice. Hedley noted two species were on the tablet named *Turritella carlottae*, and concluded they represented the two localities cited by Watson for this species, Bass Straits and New Zealand. Smith (Brit. Mus. (Terra Nova) Exped., 1910, Zool. Vol. ii., No. 4, 27 Mar., 1915, p. 80) pointed out that Hedley was mistaken, though two distinct species were on the tablet, and wrote: "The shell from East Moncoeur Island, Bass Strait, quoted by Watson, is preserved in a box by itself, and is distinct. It evidently was not seen by Mr. Hedley." However, Smith did not determine it: the "shell" is a broken tip of *tasmanica* Ten.-Woods, a species quite unlike Hutton's *vittata*, so that in this case alone Watson confused three species. More interesting to the student is the extreme localisation of the species and the geographical variation. After collecting many species in Twofold Bay and Disaster Bay, in depths from 5-25 fathoms, a single dredging in 12 fathoms off Gabo Island, only a few miles further south, showed a very distinct species.

When Miss Donald wrote, twenty years ago, she noted the difficulty of identifying two Australian species *Turritella sophiae* Brazier and *Turritella higginsi* Petterd, neither of which had been figured. I have not found figures of these yet, and Tate and May cite the latter as a synonym of *T. accisa* Watson, and the former as not known to them.

(593) TURRITELLA GUNNII Reeve, 1849. (Plate xxxvi., figs. 3, 12, 13.)

Hundreds of specimens were dredged by Roy Bell in Twofold Bay in from 15-25 fathoms. Variation in sculpture and form could be well studied and radular characters easily investigated. The opercular features showed this to be quite distinct from that of *Colpospira*, while, similarly, the *quadrata* series were proved to belong to that genus, only subgeneric status being permissible for *Platycolpus*. The recognition of the *gunnii* group as a distinct genus is thus necessary, as in the characters of the protoconch, due to their viviparous habit, it also differs.

I propose for the species *T. gunnii* Reeve the new generic name *Gazameda*, and conclude this name should be used for the Australian Turritellids with long spires, sinuate mouth, peculiar protoconch, viviparous habits, simple operculum, as distinct from *Colpospira*, of shorter growth, more sinuate mouth, different protoconch, non-viviparous habits and complex operculum.

Watson's *T. philippensis*, described from one young dead shell from 33

fathoms in Bass Straits, has been rightly regarded as synonymous with the present species. It may be, however, that it represents a geographic or bathymetric form. The specimens from 50-70 fathoms off Green Cape all tend to emphasize the ante-sutural roll (Plate xxxvi., f. 13) seen in the picture of *philippensis*, and generally absent or obsolete in the shallow water shells (Plate xxxvi., f. 12). Again, the shells dredged in 18-25 fathoms in Disaster Bay appear a little broader on the average and more strongly sculptured (Plate xxxvi., f. 3), though I have thousands from Twofold Bay shallow water for comparison, and, further, the deepwater shells above noted are narrower. Moreover, I observe that the females containing young are broader shells than others which have no young, and which I take to be males. It may be, however, that the ones without young are simply immature and that they do not produce young until a certain age. Against this may be noted the fact that very large shells were found to possess no young, but such cases should be dissected on the spot and sex noted.

(594) TURRITELLA OPULENTA Hedley, 1907.

It was obvious from the figure and description that this was not referable to *Turritella*, as commonly understood, and study of these had suggested the genus *Argyropeza* Melvill, which I had recognised from dredgings elsewhere.

Specimens turned up in the 50-70 fathom dredging off Green Cape, N.S.W., and these were seen to differ in features of the shell not easily determined from a description. I propose the new generic name *Glyptozaria* for this species alone, and this will distinguish it and draw attention to it. All the Australian members of the family Turritellidae have a sinus in the outer lip, more or less deeply marked, and in this species there is no sign of such a sinus.

I note that a fossil relative of this form exists among the Muddy Creek fossils in the British Museum, confused with Tate's *gemmulata*, and this adds to the very close alliance of the recent deepwater shells of southern New South Wales and the Muddy Creek series.

(595) TURRITELLA PARVA (Angas, 1877).

This species, described as a *Torcula*, has been recognised by Hedley, and, as in other cases, a reconsideration seems necessary, as the type in the British Museum does not seem to belong to the family Turritellidae at all. The mouth is broken, but the columella shows a basal point which suggests a canal, and thus *Seila*, but the whorls are a little pagodoid, and definite identity with any species known to me could not be established.

I have again re-examined this shell, and note that, as well as the outer lip being broken, the apical whorls are missing and the columella is slightly twisted, but the presence of a canal seems definite, and certainly the shell is not a Turritellid.

(596 A) COLPOSPIRA GUILLAUMEI, n.sp. (Plate xxxvi., figs. 4, 15).

Small for the genus, attenuately subulate, periphery keeled on later whorls, mouth nearly circular, outer lip deeply broadly sinuate (fig. 15). Colour pinkish-white suffused with fulvous and irregularly blotched with darker patches of the same colour. Apical whorls smooth and whitish, sutures deeply impressed, whorls flattened, periphery keeled, base rounded. The adult sculpture consists of a few transverse ridges, but mainly of growth lines, sinuate longitudinals following the mouth, more marked anteriorly. Columella nearly straight, faintly twisted anteriorly. Operculum typical. Length of type 15 mm.; breadth 5 mm.

Abundant in 5-15 fathoms in Twofold Bay, N.S.W.

This well-marked little species differs from *C. quadrata* (Donald), its apparent nearest relative, in its lack of transverse sculpture, and the quadrate whorling, as well as size.

(596 B) Colpospira quadrata (Donald, 1900). (Plate xxxvi., f. 5.)

Turritella (*Colpospira ?*) *quadrata* Donald, Proc. Malac. Soc. Lond., iv., Aug. 1900, p. 53, Pl. v., figs. 8-8b: Bass Strait.

This occurs in most of the deeper water dredgings from 25-70 fathoms, and, upon reference to the Muddy Creek fossils, I was surprised to find so much distinction, that, with the few specimens here, little could be definitely ascertained as to the ancestry of the recent species. A large species, *Turritella conspicabilis* Tate, was seen to have "quadrate" whorls when juvenile, but with different sculpture from the present species, and to grow to a much larger size than any recent shells I have seen. It might, however, bear the same kind of relationship to the recent shell as the huge *C. runcinata* recorded by Verco from South Australian seas does to the small *C. sinuata* from the Port Jackson area.

(597 A) Colpospira runcinata (Watson, 1881).

When Watson wrote his preliminary descriptions (Journ. Linn. Soc., Zool. xv., 1881, p. 218) he described *Turritella runcinata* from the 38/40 fathom dredging off East Moncoeur Island, Bass Straits. Two pages later (p. 220), from the same locality, he added *Turritella accisa*, and on p. 224 he introduced *Turritella cordismei*, also from the same dredging. The series in the first two cases consists of three shells each, while in the last, four specimens were included. Miss Donald drew attention to the great similarity between the first two, and noted that the last named were juvenile. The three *runcinata* are larger and broader than the three *accisa*, but I conclude they are absolutely identical. The sculpture varies, and each set contains finer and coarsely sculptured shells. The four *cordismei* are really only two, as two unrecognisable dead tips are included: the other two are young, rather narrower shells, but almost certainly the same species: the larger is more smoothly, but the smaller is more coarsely, sculptured.

Then what is the shell recorded by Verco from South Australia under the name *T. accisa?*

A few specimens of *C. sinuata* (Reeve) were picked out of the shallow water dredgings, but mostly in the deeper series, about 20 fathoms, in Twofold Bay, and sometimes were accompanied by *C. runcinata* (Watson), and the variation in each makes it difficult to determine their validity, without long series. My first conclusion was that *runcinata* was the southern form of *sinuata*, and this may be the correct one, but their occurrence together suggests their specific distinction, in which case Watson's *T. cordismei* might be referred to *sinuata*, and would represent the southern stage of the species.

Examination of the few Muddy Creek fossils available here, suggested that *platyspira* Ten.-Woods was the fossil relative of *sinuata*, and that the latter may be preserved as a distinct species, but I hope that this species or group of species will be studied with a view to the variation existent, as Verco has proclaimed himself puzzled with his large series from deepwater, and I think they are very variable.

Miss Donald noted (p. 50) "*Murchisonia sutoris* as a manuscript name given by Dunker to specimens in the Godeffroy Museum, collected by Captains Schultze,

Pohl and Witt in Bass Strait, the best being probably obtained by the last named." As this indicates uncertainty and error, some facts may be here recorded. In the Museum Godeffroy Catalogue (iv., May, 1869), a preface dated 18 May, 1869, by J. Schmeltz, Jr., states that the shells have been determined by Dunker. A "Topographische und Zoologische Notizen" gives excellent details of the collectors for that once famous Museum with an account of their collecting grounds. On p. xix. it is noted that Captain Wendt (not Witt as Miss Donald quoted from Pfeffer's letter), in the Gulf of St. Vincent near Adelaide and on the south coast of Australia, dredged new species of shells, as well as known but rare species as *Myadora pandoriformis* Stutchb. Captain Wendt also dredged in Bass Strait, but later Captain Schultze dredged also in Bass Strait and in his collection there were specimens of the genus *Murchisonia*, hitherto only known in the fossil state, but the specimens were poor. Captain Schultze also collected, at the same time, *Crassatella castanea* Reeve, *Myochama keppelliana* Reeve and *Pectunculus laticostatus* Quoy and Gaimard. Digressing, it may be noted that the *Crassatella* were typical *kingicola* Lamarck, and that the *Pectunculus* referred to the New Zealand *laticostatus* Q. and G. was the one I have written about under the name *Glycymeris flabellatus* Ten.-Woods, and is the earliest record of this species. In the Catalogue iv., no *Murchisonia* is included, but on p. 77 "No. 3433 *Torcula tenuilirata* Dkr., n.sp. B(ass) S(tr.)" appears without any description. In Catalogue v., published Feb. 1874, there is "p. 148, No. 3433 *Murchisonia sutoris* Dkr. = *Torcula tenuilirata* Dkr. i. l. Mus. Godeffroy Cat. iv. Bassstrasse," and in the Corrigenda, p. 212, a note "ist eine Turritellide zum Genus *Zaria* gehörend (O. Semper)."

(600) TURRITELLA SUBSQUAMOSA Dunker, 1871. (Plate xxxvi., figs. 11, 14.)

A remarkable shell was found in the 15-25 fathom dredgings, in that it was only about halfgrown, with the mouth always broken; in no specimen did I find a perfect mouth, the outer edge being extraordinarily thin, and fractures could be traced along the shell. Three magnificent shells were dredged in a single haul at 25 fathoms, and upon comparison these proved to be the long-lost *Turritella tasmanica* Reeve (Conch. Icon., Vol. V., June, 1849, Pl. ix., sp. 42), described from Van Diemen's Land, from Dr. Sinclair's collecting, the type in the British Museum. Tate and May recorded the name and wrote "= *T. lamellosa* (?)." Hedley regarded the latter as a synonym of Dunker's species and the description given by Dunker agrees very well with that of Reeve. Specimens from Bass Strait, the types of Watson's *lamellosa*, differed from Reeve's type only in the suppression of the spirals and the greater prominence of the longitudinal threads. South Australian shells, labelled *oxyacris* Tate, a name also regarded as synonymous, showed a still further advance, the longitudinals overriding the almost obsolete spirals. In the most northern shells the latticing between the spirals is scarcely noticeable, and the form then looks quite distinct, and, moreover, looks like a form of *gunnii* with coarse spirals, but it is always a narrower shell.

Contrariwise, a fossil from the Muddy Creek beds, labelled *Turritella murrayana* Tate, showed a complete lamellose sculpture with very subjunctive spirals, recalling the South Australian *oxyacris* above noted, but was very much broader and was ranked as a variant of other shells showing no lamellose striations but simply very close spiral sculpture, much closer than any form of *gunnii*, though that species varies in breadth as well as sculpture.

(605) CROSSEA CONCINNA Angas, 1868.

This species was commonly found as dead shells in shell grit from a few feet of water at low tide, but a living specimen revealed a multi-spiral operculum of rather thick horny texture. This necessitates the transference of the species to the family Liotiidae and the proposition of a new genus, a view previously held from a criticism of the shell features alone. I propose *Crosseola,* with this species as type, and would temporarily range along with this the other globular Australian species classed as *Crossea,* e.g. *carinata* Hedley, *naticoides* Hedley, *cancellata* Ten.-Woods and *consobrina* May, and the fossils *Crossea princeps* Tate and *C. semiornata* Tate. The species (606) *Crossea labiata* Ten.-Woods, which Bell sent also, is a different group altogether, and its family location must remain doubtful until live specimens are examined. It has, however, still less apparent relationship with typical *Crossea,* and cannot be included with the above, so I introduce the new generic name *Dolicrossea,* naming *C. labiata* Ten.-Woods as type. The fossil *Crossea sublabiata* Tate seems only trinomially separable, while the fossil *C. lauta* Tate has no living representative yet on record (Trans. Roy. Soc. S. Austr., xiii., 1890, pp. 220-2, figs. on plate viii.).

(608) LIPPISTES TORCULARIS (Ten.-Woods, 1878).

Only one well acquainted with the literature of Australian marine molluscs would have recognized the shell under this name, as nothing much more unlike the type of *Lippistes* could be found to bear that generic name.

I herewith propose *Icuncula,* with *Cingulina torcularis* Ten.-Woods as type, and question the matter of variability. Hedley allows two species, *torcularis* Ten.-Woods and *zodiacus* Hedley, and May has since described another, *L. consobrina,* comparing it with Brazier's *gracilenta.* Probably some of these will be lumped when series are available, as, allowing the same standard, *Lironoba australis* might be split into half a dozen.

Only one specimen was found in a dredging from 15 fathoms in Twofold Bay, and this I refer to the present species.

Referring to *Lippistes,* this generic name is older than *Trichotropis* and the family name would be Lippistidae. As to the name of the Victorian and South Australian species, the more writers, apparently, the more confusion. Hedley gave a note, based upon British information, and his nomination is incorrect. Pritchard and Gatliff (Proc. Roy. Soc. Vict., xviii., n.s., pt. 2, 1906, p. 55) accepting *blainvilleanus* Petit in place of their own *gabrieli* stated that Hedley then accepted the distinction between *L. separatista* Dillwyn and *L. blainvilleanus* Petit. At the same time, Verco reported upon these forms and accepted *L. separatista* upon E. A. Smith's assistance and recommendation. Since then, Smith altered his opinion and recorded *Lippistes helicoides* Gmelin, which is the correct name for Dillwyn's *separatista,* from Cape Colony, South Africa. This leaves the South Australian shell to bear Pritchard and Gatliff's name *gabrieli* as the only certain one, until actual comparison is made with the type of *blainvilleanus.* There appears to be little variation individually, and the named forms appear to be geographic representatives of full specific rank. In any case, the South African shell is clearly and constantly distinct from the South Australian species, and also from the Philippine shell studied by Verco, and now separated by Smith.

(623) STRUTHIOLARIA SCUTULATA (Martyn, 1784).

The recognition of the genus *Tylospira* seems necessary, inasmuch as fossil representatives of this form are known living alongside fossil forms of *Struthiolaria* s.str., thus proving the antiquity of the separation and, consequently, its generic value.

Under No. 30 *Arca trapezia*, I have quoted Dall's views, and here add his further conclusion "The estimation of values in such cases is liable to a large personal equation." I absolutely agree, and point out that as in this case, an ancient difference should have more value allotted to it than a recent one.

Tylospira was proposed by Harris (Cat. Tert. Moll. Brit. Mus., part i., 25 Mar. 1897, p. 222) with the present species named as type. The radula of *Tylospira* differs appreciably from that of *Struthiolaria*, and I hope to figure it later in conjunction with other comparisons of the fossil and recent forms of this group.

(624) ZEMIRA AUSTRALIS (Sowerby, 1841).

One of the greatest puzzles of Australian systematic malacology has *not* been solved by study of the radula. Dr. A. H. Cooke has published an account (Proc. Malac. Soc. Lond., xiii., Aug., 1918, p. 12), wherein he states that the radular characters of this strange mollusc are only comparable with those of *Oliva* and *Murex*, and suggests placing the species near the latter with generic (not subgeneric) rank. Of course he should have said Family rank, as obviously that was the correct value, on account of the abnormal shell and opercular characters.

Specimens from Disaster Bay, 10-20 fathoms, were a little larger with a lower spire than the ones from Twofold Bay in the same depths. I note this, as the Muddy Creek fossil *Z. praecursior* Tate is differentiated by that feature, and there is no series of the fossil available. A family Zemiridae, next to the family Olividae, would best express our present knowledge of this form.

(628 A) NARICAVA VINCENTIANA (Angas, 1880).

Adeorbis vincentiana Angas, Proc. Zool. Soc. Lond., 1880, p. 417, Pl. xl., f. 9: Aldinga Bay, Gulf St. Vincent, S.A.—*Vanikoro denselaminata* Verco, Trans. Roy. Soc. S. Aust., xxxiii., 1909, p. 334, Pl. xxix., figs. 1-3: Gulf St. Vincent, S.A.—*V. vincentiana*, Verco, ibid., xxxiv., 1910, p. 118 (full account and synonymy).

This is an addition to the N.S.W. List, specimens having been sorted out of the Twofold Bay shallow-water dredgings.

(645) EPITONIUM GRANOSUM (Quoy and Gaimard, 1834).

Hedley (These Proc., 1901, 20 May 1902, p. 701) recognised *Scalaria ballinensis* Smith (Ann. Mag. Nat. Hist., Ser. 6, Vol vii., 1891, p. 139) from Ballina, N.S.W., as a synonym of *Scala granosa* (Q. and G.) which he considered "common, widespread and variable." He gave a figure of Smith's species (Pl. xxxiv., f. 21).

I have received shells from Port Fairy, Vic., which are all broader than a series from Cape Naturaliste, W. Aus., which may be regarded as typical of *granosa*, described from King George Sound. Roy Bell's collections from Twofold Bay included specimens which were determined as *ballinensis* from Smith's types, and these are constantly separable from either of the other sets. I

advise, therefore, the reinstatement of *ballinensis* in the N.S.W. List in place of *granosum*.

As "*granulosa* Q. and G.," this species is the type of *Granuliscala* Boury, 1909, which will come into use, when work is undertaken on this group again.

(660) AUSTROTRITON PARKINSONIUS (Perry, 1811). (Plate xxxv., f. 4.)

When Kesteven wrote upon *Lotorium* (These Proc., 1902, p. 443 et seq.) he grouped with *parkinsonianum, radiale* Tate, *abbotti* Ten.-Wds., *textile* Tate, *woodsi* Tate and *tortirostris* Tate, Australian Tertiary fossils. He later gave figures (These Proc., xxxvii., 1912, p. 49 et seq., Pl. 1) of *tortirostris, abbotti* and *parkinsonianum,* dwelling upon their close relationship, concluding *C. parkinsonianum* is apparently the recent form of *C. tortirostris*. This is indisputable, but the examination of specimens from 50-70 fathoms off Green Cape provided an interesting complication. Obviously related to *parkinsonianum,* they differed a little in shape, narrower, longer spire, longer canal (Pl. xxxv., f. 4), and approximated more in sculpture to the fossil form. The series could be well named in the manner I am suggesting for such cases thus:

Austrotriton parkinsonius Perry. The shallow water coastal species. *A.* [*parkinsonius*] *basilicus* n. subsp. Deeper water relation. *A.* [*parkinsonius*] *tortirostris* Tate. The fossil form.

(667) CYMATIUM SPENGLERI (Perry, 1811).

As a synonym must be added *Triton* (*Cabestana*) *boltenianus* A. Adams (Proc. Zool. Soc. Lond., 1854 (8 May 1855), p. 311): Australia. This species was named from a specimen in the Mus. Cuming, now in the British Museum, and Angas recorded it in 1867 from Long Bay, Port Jackson, and presented specimens to the British Museum. When Hedley studied the British Museum Collection, he concluded that these were all extra-limital, as the species was unknown to Australian malacologists, and that some confusion of localities had taken place. From Port Fairy, Vic., Roy Bell sent a small dead shell and then from Mallacoota, Vic., another one came, but from Twofold Bay he sent a fine large shell, alive, which agreed exactly with the type of *boltenianum*, and I intended to reinstate it, when I found I could not easily distinguish the small ones from the admitted juveniles of *spengleri*. Hedley at once recognised the large shell as an aberration of *spengleri*, and I agree. The type of *barthelemyi* Bernard is in the British Museum and is another variation of this species.

(667 A) CYMATIELLA QUOYI (Reeve, 1844).

Triton quoyi Reeve, Conch. Icon., June 1844, Triton Pl. xix., f. 93: New Holland, Mus. Cuming.— *T. verrucosus* Reeve, ib., xvii., f. 71: Hab? Mus Cuming.—*T. eburneus* Reeve, ib., xvii., f. 69: I. Ticao, Mus. Cuming.

These three appear as distinct species in Tate & May's Census for Tasmania, while Pritchard and Gatliff lump the first two under the name *verrucosus*, and also accept *eburneus* as Victorian. The type of *eburneus* seems to me to be Philippine, as given by Reeve, and the other two represent two forms of one species, in which case *verrucosus* is the name for the species. As the slender form has been recognised as distinct, and I cannot determine the point, I am using the name *quoyi* for the form I now add to the N.S.W. List from Twofold Bay, dredged in shallow water, as my specimen is especially slender, but not as

slender as the deep water form. I am introducing the new generic name *Cymatiella,* with *quoyi* as type, for these peculiar little Australian forms.

(682 A) PHALIUM PYRUM (Lamarck, 1822).

Cassis pyrum Lamarck, Hist. Anim. s. Vert., Vol. vii., 1822, p. 226: New Holland, i.e., East Tasmania; Kiener, Coquilles Vivants Casque, 1835, p. 39, Pl. 13, f. 25.—*Semicassis paucirugis* Angas (not Menke), Proc. Zool. Soc., 1877, p. 183. Twofold Bay.

The species of *Phalium* inhabiting extra-tropical Australia are of great interest, and I hope to monograph them shortly, as so many diverse views have been held as to the species and nomination. Roy Bell sent from Mallacoota many specimens of the present species and *C. semigranosum* Lamarck (named at the same time by Lamarck and probably collected by Peron in the same place simultaneously). From Twofold Bay he sent the present species and *P. labiatum* Perry (typically coloured, but a little more globose, apparently its southern limit) as shore and shallow water shells; from 25 F. a specimen of *P. stadiale* Hedley not quite typical, and from 50-70 F., off Green Cape, a young typical specimen of *P. stadiale* Hedley. The recent trawling expeditions have brought up many *C. thomsoni* Brazier, *C. sophiae* Braz., and *C. stadiale* Hedley, showing all these to be constant geographically and bathymetrically. I have collected a number of shore specimens, on the Sydney beaches, of *P. labiatum* Perry, all agreeing in coloration and form.

The present species was recorded as *S. paucirugis* by Angas from Twofold Bay; Hedley also collected it there, and now Bell has got it, and all the specimens are alike, showing little variation from the Mallacoota and eastern Tasmanian shells. From Kiener's figure of *C. pyrum* Lamarck, I should conclude the species was collected by Peron in eastern or southern Tasmania.

(691 A) NATICA SHOREHAMI Pritchard and Gatliff, 1900.

Natica shorehami Pritchard and Gatliff, Proc. Roy. Soc. Vict., xiii. (n.s.), Aug. 1900, p. 131, Pl. xx., f. 4: Port Phillip, Victoria. A few small shells were sorted out of shallow water dredgings in Twofold Bay, N.S.W., along with *N. subcostata* Ten.-Woods (which ranged in size to 13 x 11 mm.), each with the operculum, that of the former being as yet undescribed, and is here stated to be solid, shelly, smooth, showing a slight prominence following the initial whorling, while there is a very obscure sulcus near the edge. This would place the species in the genus *Cochlis* Bolten, Museum Bolten, 1798, p. 146, accepting *C. albula* Bolten as type, the typical *Natica* having the sulcate operculum like that of *N. subcostata* Ten.-Woods.

(702) SINUM PLANULATUM (Recluz, 1843).

This is referable to *Sinum,* but the specific name is not acceptable. *Sigaretus planulatus* was published by Recluz in Illustr. Conchyl. (Chenu), in his Mon. Sigaret (p. 21) and figured (Pl. 3, fig. 4). His specimen came from "Iles Séchelles, au port Mahé," and he attached to it "Gualt., Index test., 1742, Pl. 69, fig.. F. inferior," as depicting his species. On p. 1 of his Monograph, he had introduced *Sigaretus planatus* for the Gualtierian species. Chenu's Illustrations appeared piecemeal, and a collation has been prepared by Sherborn and Smith, and published in the Proc. Malac. Soc. Lond., ix., Mar., 1911, p. 264 et seq. From this we get the information

Sigaretus, pp. 1-4	Pls. 1-2	in part 5	recd. British Museum	11. 5.1843
5-8	8-10			10. 8.1843
9-12	16			7.12.1843
13-20	22			7. 3.1844
21-24	25		apparently	5. 6.1844

From this it would be concluded that the name must be *planatus*, and if the Seychelles shell is different from Gualtier's species, another name must be used for it.

Later in his "Catalogue" of the species of *Sigaretus* (Journ. de Conch., ii., 1851, p. 163, et seq.) Recluz records his *planulatus* from the Philippines, and adds his *gualterianus* olim as a synonym.

For the species named *zonalis* by Quoy and Gaimard, Tryon used Lamarck's *Sigaretus laevigatus* (Hist. Anim. s. Verteb. Vol. vi., pt. 2, Apr., 1822, p. 208) from the seas of Java, and adds as synonym *Sicaretus* (sic) *australis* Hanley (Conchologist's Book of Species, 1840, p. 57, frontispiece plate, f. 3). In the 2nd revised edition, Hanley added an Index with names of authorities and localities, and there (p. 153) this name is credited to Gray and South Seas is given. Shells in the British Museum labelled "*australis* Hanley" from the I. of Luzon, which may be the types, are easily separable from *zonalis* Q. and G., but belong to that group, which differs from the *planulatus* series, also shown from the I. of Luzon. It is interesting to note that Recluz, the monographer of this group, always separated the shells into two series, and at first sight this seemed splitting, but upon fuller knowledge it shows great insight, and a detailed investigation of the anatomy of these two groups would be interesting. The radula of the whole series is peculiar, but there are too few specimens in the Gwatkin Collection to make any comparison of value. I have, however, a few shells sent by Roy Bell with their animals, and I will later report upon their radulae.

Since this was written, Robson has given a short account of the external characters of *Sinum planulatum* (Recluz) (Proc. Malac. Soc. Lond., xv., 1923, p. 268-269), but appears to be ignorant of Quoy and Gaimard's figures of their *C. zonalis* (see post), nor does he quote Recluz' excellent figures (loc. cit.).

(702 A) Sinum zonale (Quoy and Gaimard, 1833).

Crysptotoma (sic) *zonalis* Quoy and Gaimard, Voy. de l'Astrol., Zool. Vol. ii., 1833, p. 221, Pl. 66 bis, figs. 1-3: Garden Island, King George Sound, W. Aust.

This Adelaidean species has drifted round the corner, occurring in shallow water dredgings from Twofold Bay, and being an addition to the N.S.W. List.

(703) Sinum umbilicatum (Quoy and Gaimard, 1833).

The more common shells give the most trouble and the present species is a good instance. Recently a lumping policy has been adopted, but a revision seems necessary. Verco has described a deepwater representative of this species from South Australia, and the shells from 60-70 fathoms off Green Cape, N.S.W., are distinguishable from the shore and shallow water specimens by being depressed and flatter. However, shallow water South Australian shells seem more conical, with a smaller mouth and smaller umbilicus than Tasmanian shells, while these are much larger than any of the N.S.W. specimens. There are four names at present available, *umbilicata*, *globosa*, *picta* and *albosutura*, the last named being

regarded as very distinct. The type locality of *umbilicata* has not yet been fixed, but I here designate Tasmania, where Quoy and Gaimard collected, and where it is a common shell.

The name *pictus* can then be used for the South Australian form, and I propose to differentiate the Peronian forms. However, the generic name must be first fixed. In the Check List, Hedley has placed the species under *Sinum*, which is obviously undesirable, as the animal is retractile, while that of *Sinum* is not; moreover, this species is "*umbilicata*," whereas *Sinum* shows the very opposite. Pritchard and Gatliff and Verco have used *Eunaticina*, which is conchologically preferable, but the shell features still do not agree. I therefore concluded that a new generic name was necessary, but thought examination of the radulae in the Gwatkin Collection might prove interesting. The species of *Polinices* I examined, such as *conica*, *plumbea*, *melastoma*, all showed a rhachidian tooth, with three large practically even cusps. The radula of *Sinum*, as shown by *zonalis*, has a tricuspid rhachidian, but, while the two side cusps are long, the central cusp is short, only about half the length: this is characteristic of *Sinum*. The radula of *picta* sent by Verco from St. Vincent's Gulf, S. Aust., at once showed a notable distinction as, though the rhachidian might still be termed tricuspid, only the central tooth was strongly developed, the side cusps only showing as minor projections near the base. The radula of *papilla*, the type of *Eunaticina*, is nearest this, but is recognisable and well differentiated by means of its unicuspid rhachidian. I have just indicated the above differences, but they are supported by the shape of the base of the rhachidian tooth, the size and shape of the laterals and marginals.

Consequently, the necessity of distinguishing the present species generically is proven, and I propose the new generic name *Propesinum*, and would name the New South Wales sub-littoral form *Propesinum umbilicatum minusculum*, n. subsp., as being smaller, with less elevated spire, columella more reflected, umbilical cavity narrower, and the deepwater form, from 50-70 fathoms off Green Cape, *P.* (*u*) *mimicum*, n. subsp., as being still less, more flattened, umbilical cavity wider, etc. This might be contrasted with *albosutura*, thus *P.* (*albosuturum*) *mimicum*.

(706) CYPRAEA ANGUSTATA COMPTONI (Gray, 1847).
(706 A) CYPRAEA ANGUSTATA PIPERATA (Gray, 1825).

Specimens were received in numbers, as dead shells, from Tellaburga Island, Vic., and a few from Twofold Bay, N.S.W. Confirmation of the data given for the name necessitates the absolute rejection of *angustata* in any sense. Verco (Trans. Roy. Soc. S. Aust., xlii., 1918, pp. 140-144) has given an excellent review of the forms of the species, but he did not discuss the determination of Gmelin's name. I find that Gmelin's sole basis of his *Cypraea angustatā* (Syst. Nat., Vol. i., pt. vi., 1791, p. 3421) was "Gualt. test. t. 13 f. QQ" from unknown habitat. Gualtier's figure does not represent our shell, and it was published in 1742, long before any South Australian shells reached Europe. Its acceptance is apparently due to J. E. Gray, who added the locality "New Holland," and noted it had been ignored by the French writers, at the same time as he correctly described *Cypraea piperita* (Zool. Journ., i., Jan., 1825, p. 498), also from New Holland. Sowerby (Conch. Illus., 1832, sp. 100, p. 10, f. 24) when he figured *piperita* gave New South Wales, and at the same time referred *angustata* Gmelin to South Africa.

The specific name will then be *Cypraea piperita* Gray, 1825. Hidalgo (Monog. Gen. Cypraea, Mem. Real Acad. Cien. Madrid, 1907, pt. 2) used (p.

254) Gmelin's *Cypraea angustata* for the Australian shell, citing *Cypraea maculata* Perry (Conchology, 1811, Pl. xx., f. 5) as a synonym. Perry's shell was simply localised as Eastern seas, the coloration is poor, the size is too big, and there is apparently a prior *C. maculata* (Encycl. Metrop., Pl. 14) published in 1810. Gray's *C. comptoni* was described from Port Essington and, if that locality be incorrect, it came from southern Tasmania, and would be applicable to the form living there, which has several varietal names, correctly recorded by Verco.

(709) Cypraea armeniaca Verco, 1912.

Verco fully discussed the species *umbilicata*, with its western representative, when he varietally proposed the above name. Since then the eastern species has been trawled in numbers, so that a better idea of its variation can be gauged. After examining a large series, I would allow *C. armeniaca* Verco specific rank, as it appears more distinct from the eastern *hesitata* (i.e., *umbilicata* olim) than some of the fossil relations from the Muddy Creek beds. The variation used for the separation of such fossils as *C. eximia* Sowerby, *C. toxorhyncha* Tate and *C. sphaerodoma* Tate may be due to their receipt from different horizons, or even simply individual variation. The recent *hesitata* varies in size and shape, but I have not seen one which showed so much altitude as Verco's measurements, or with so obscure a "snout" for the size. Tate regarded the fossils as scarcely referable to Jousseaume's *Umbilia*, founded on the recent *umbilicata*, but I would regard the series as closely related, and, further, that they would come into a larger group centring in *scotti*, which Jousseaume named *Zoila*, and I would use *Zoila* generically and *Umbilia* subgenerically for these strange coldwater umbilicate "living" and "dead" fossils. In their latest Alterations, Gatliff and Gabriel (Proc. Roy. Soc. Vict., xxxiv. (n.s.), May, 1922, p. 141) have correctly separated *armeniaca* specifically, but have used, for the eastern form, *Cypraea alba* ex Cox with a var. *hesitata*. Cox's name was only proposed varietally, and in this sense was preoccupied in the earliest illustrated Monograph of Cypraea three times, viz., *Cypraea spurca* var. *alba* Sowerby, Conch. Illus., 1832 and 1837, p. 6, p. iii.; *C. turdus* var. *alba* Sow., ibid.; *C. lamarckii* var. *alba* Sow., ib., p. iv.

(735) Trivia australis (Lamarck, 1822).

Introduced as *Cypraea australis*, I find Lamarck had been anticipated by Schroeter (Archiv. Zool. (Wiedeman), iv., pt. i., 1804, p. 10), and I also note no synonyms. *Cypraea rosea* is sometimes noted as of Duclos, cited by Potrez and Michaud (Galerie des Mollusques Douai Vol. i., Oct., 1838, p. 477), where it appears as a synonym of *C. australis* Lam., but it is antedated by *Cypraea rosea* Wood (Index Test., Suppl., 1828, p. 9). I am describing as a new species:

Triviella merces. (Plate xxxv., f. 16-17).

Well known under the name *Trivia australis* (Lamarck).

Shell of medium size for the genus, mouth fairly wide, aperture longer than the spire and body whorl; spire noticeable as an obsolete bump overlaid by the spiral body sculpture which consists of narrow ridges about one-third the width of the interspaces, which are smooth or only slightly transversely scratched; a smooth patch exists on the back until senile. Twenty-four ribs denticulate the outer lip and about sixteen the inner lip. Length 14 mm.; breadth 9.5 mm.; height 6 mm.

Common on the littoral of New South Wales.

(754-765) Family VOLUTIDAE.

Roy Bell sent me specimens of the species No. 755 and 761 only, but, as I have a few notes on the nomination of the group, I take this opportunity of recording them. Lamarck wrote in error *Voluta ondulata* when describing his species from Bass Straits and Ile Marie, Eastern Tasmania. Bell's specimens from Twofold Bay are consequently typical and *V. angasi* Brazier is an absolute synonym, the wrong form being named, that from Port Lincoln and the Great Australian Bight requiring a varietal designation. It may be of interest to note that Peron called this species *Voluta undulosa*, and, peculiarly, the same change in the ending of the name given by Solander appears in literature, his name being given sometimes as *fluctuata*, and at others as *fluctuosa*, but in each case no description was offered.

Voluta maculata Swainson (Appendix to Bligh Cat. Shells, 1822, p. 11), regarded as the type of *Scaphella* by Hedley, must be renamed, as there is a prior *Voluta maculata* Menschen (Zoophyl. Gronov., fasc. iv., Index, 1781). I propose to rename it *Scaphella caroli*.

No. 757.—An earlier reference for *Voluta magnifica* is Shaw (Nat. Miscell., xix., 1808, Pl. 812).

No. 759.—*Voluta punctata* Swainson, 1823, was anticipated by Allan (Trans. Roy. Soc. Edinb., viii., 1818, p. 461, ex T. Brown MSS.) for a Nice fossil. This recent shell I rename *Cymbiola complexa*.

An extralimital form must also have a name-change, viz., *Lyria mitraeformis* ex *Voluta mitraeformis* Lamarck, a northern Tasmanian and Victorian shell, as Lamarck in his choice had been anticipated by Brocchi in 1814, but fortunately there is an excellent alternative in *Voluta multicostata* Broderip (Zool. Journ., iii., 1827, p. 82) from unknown locality, the excellent figure (Pl. 3, f. 2) being unmistakable.

(768) Olivella leucozona A. Adams and Angas, 1864.

Many specimens were collected in the shallow water dredgings in Twofold Bay, and, though showing variation in size and shape, agreed with the types of *brazieri* Angas, which Hedley regarded as a variety. The type locality of *leucozona* was Port Jackson, while *brazieri* was named from Newcastle, and, if these were geographical variants, my shells should have been nearer the type series. While puzzled, I secured Brazier's copy of his reprints of Angas's papers and found therein the information "Jervis Bay, 10 Fathoms, Angas wrong with locality" in Brazier's handwriting, the name Newcastle being crossed out. Brazier apparently also told Whitelegge this, as the latter simply wrote Jervis Bay in his List, *but without any remark*. The species *exquisita* Angas was not found by Bell, but described from Coogee Bay, I find it in shell sand from this place, and it appears strictly congeneric with the present species.

As regards the generic name, *Olivella* cannot be maintained. This was proposed for American shells, and Dall has discussed the groups (U.S. Geol. Survey, Prof. Paper, No. 59) without mentioning the Austral forms. At sight these differ from American shells, the name of the type, *biplicata*, referring to the columella, recording an obvious difference. Unfortunately, the Australian species, though so few in number, do not constitute a homogeneous assembly, the small, thin, unicoloured shells, conchologically, being generically separable from larger solid coloured ones. To determine this matter definitely, I handed specimens to my friend, Lieut.-Col. Peile, who found such great differences that he recorded them (Proc. Malac. Soc. Lond., xv., 1922, p. 18), making a few remarks, while

proposing the new genus *Belloliva* for Angas's *brazieri*. Thus the conclusions formed by study of geographical factors and shell features are confirmed by this radular examination, and the latter in its turn furnishes a clue to the affinities of one form, while inviting further research as to the relationship and reason of the other. The teeth of *brazieri* may be compared with those of *Oliva*, whereas the general features of the radula of *nympha* are those observed in *Olivella*. There are minor differences, but the obvious distinction is in the form of the central tooth or rhachidian. In *brazieri* this is tricuspid like that of *Oliva*, while that of *nympha* is multicuspid, recalling that of the American *Olivella*. *Oliva* has, however, no operculum, whereas *Olivella* possesses a well-formed operculum, which is seen in both *brazieri* and *nympha*. It is here suggested that *Oliva* has evolved from an Olivelloid ancestor, the tricuspid rhachidian being of later origin than the multicuspid form, while the loss of the operculum is also due to specialization. Then we may regard the present Olivellas as remnants of a large family, persisting only on the outskirts of the range, and retaining the more primitive radula and operculum. We then see in *Belloliva* an *Olivella*, which, retaining its operculum, has developed an *Oliva* radula. As noted above, *exquisita*, from shell characters, may be placed in *Belloliva*, but *pardalis* A. Ad. and Ang. = *triticea* Duclos, differs a little in shell characters, as also in radular features, though generally agreeing with *Belloliva*, and the differences may be indicated by a subgeneric name *Gemmoliva*. However, *nympha*, which Peile showed to have the general radular features of the American *Olivella*, is conchologically very different from the type of *Olivella*, and must be named generically, the genus *Cupidoliva* being proposed for it as type. This species apparently shows great variation in size and shape, and my series suggests that Verco's *Olivella solidula* may be the Adelaidean representative of *nympha*, though it was not compared with that species.

(771) ANCILLA CINGULATA (Sowerby, 1830). (Plate xxxvi.).

This species apparently is included in Hedley's Check List from a northern locality, as I collected it at Caloundra, Queensland, and it is not included in Roy Bell's collections. I have been puzzled in the determination of the series sent by him, as no fewer than six different forms appear, and Hedley had only admitted three. After much trouble I have arrived at somewhat different conclusions from those generally accepted, but I am not satisfied that the truth is known regarding these molluscs. Some years ago, I considered the generic name to be used for these Austral species and here give my results. In the British Museum cases the species are arranged under four genera as follows, *Ancilla* Lamarck, *Sandella* Gray, *Eburna* Lamarck and *Sparella* Gray. To the former were allotted all the southern Australian species such as *cingulata* Sow., *oblonga* Sow. and *australis* Sow. I found that the type of *Ancilla* was a species placed under *Sparella*, and consequently a transference of names was necessary. I also noted that *Amalda* had been proposed prior to *Sandella* and must be used. I have already recorded this point in connection with tropical Australian molluscs. I then consulted Fischer's Manuel, and noted that he had provided *Baryspira* as a sectional name for *A. australis* Sowerby and *A. glandiformis* Lamarck, Miocene. In order to avoid confusion, I here designate *A. australis* Sowerby as the type of *Baryspira*. The Neozelanic series certainly show slight conchological differences from the Australian groups now under discussion, but at present I would advise the use of *Baryspira* generically for the Austral species commonly ascribed to *Ancilla*. The shells are quite easily separable by con-

chological characters, and I have examined the Gwatkin Collection of Radulae, now in the British Museum, and find that the observed differences are confirmed by separative features in that item. I was able to class the radulae in groups which agreed with the shell groupings. The complete quotation of the generic name *Baryspira* is Fischer, Manuel de Conchyl., fasc. vi., 20 Dec., 1883, p. 600. Type (by subs. desig., Ire., 1924) *A. australis* Sow. I now pass on to the consideration of the determination of the specific names. From New South Wales Hedley has recorded only *A. cingulata* Sow., *A. edithae* Prit. and Gat., and *A. oblonga* Sow. The Victorian List reads *A. lineata* Kiener, *A. marginata* Lam., *A. oblonga* Sow., *A. petterdi* Tate, and *A. edithae* P. and G. Tate and May included from Tasmania, *A. marginata* Lam., *A. oblonga* Sow., and *A. petterdi* Tate. What each has meant by these names I cannot exactly determine from the British Museum collection and literature. *A. edithae* seems plain, as there are specimens in the British Museum so named, presented by the authors, but I did not get this species in the collections sent by Roy Bell, though Hedley has recently recorded it from very near this place. *A. petterdi* Tate, I have identified from Tate and May's figure as a species sent from Port Fairy, Vic. A shell found washed up on the shore at Port Fairy, Lakes Entrance, and Mallacoota, Vic., and dredged in shallow water in Twofold and Disaster Bays, N.S.W., was identical with a series which has been named by Hedley *A. marginata* var. *tasmanica* Ten.-Woods. These came from Port Phillip, Vic., and I accept this name upon this identification.

The next point was the recognition of *Ancillaria oblonga* Sowerby (Spec. Conch., Vol. i., pt. i., Nov., 1830, p. 7, figs. 38, 39, on Pl. 3) from New Holland, received from Port Jackson. The very good description and figure quickly determined this species as the one of which I had a very narrow form from 15-20 fathoms, Twofold Bay, but probably as quite different from current acceptance in Tasmania and southern Victoria. Pritchard and Gatliff included it on Watson's identification of Challenger shells (which I have examined) which are from Sydney Harbour, as given at the place quoted, and not Victoria. Tate and May cited it as equivalent and prior to *A. fusiformis* Petterd (Proc. Roy. Soc. Tasm., 1885 (1886), p. 342), which, according to the description, has little affinity. Sowerby definitely stated "no carinations on the spire," while Petterd wrote "spire spirally striated above and below the suture." Verco recorded *oblonga* from 100 fathoms 90 miles west of Eucla, W.A., adding "Mr. Gabriel has sent me two examples dredged in Western Port." As he gives, *fide* Tate and May, *A. fusiformis* Petterd in his synonymy, no certainty can be arrived at in this case even. Upon this record Hedley included *A. oblonga* Sow. in his W.A. List, but also included *A. lineata* Kiener, citing *A. monilifera* Reeve as a synonym. Kiener's shell closely resembles Sowerby's *oblonga*, and apparently came from Western Australia, whence many specimens are in the Australian Museum. In the British Museum, I accepted Reeve's types of his *A. monilifera* from Swan River as a distinct species from Sowerby's *A. oblonga*, and, as Kiener's name *A. lineata* had been used previously by Perry (Conchology, 1811, Pl. xxxi.), Reeve's name may be used. Sowerby's species *A. oblonga* should be crossed off the W. A. List, as I regard it as the eastern representative of Reeve's species only. Verco's *beachportensis* appears to be a deepwater form of *petterdi*, while Hedley's *A. coccinea* is a deepwater shell from Western Australian waters very different from any other species. These resolve themselves thus: *A. tasmanica* Ten.-Woods, a form which seems constantly separable from *A. marginata* Lamarck and apparently frequents very shallow water, as dead shells appear on the beaches and were sent

from the Victorian localities as picked up on shore, as well as from Twofold Bay, where specimens were also found in the shallowest dredgings, 5-10 fathoms, and Disaster Bay in 10-20 fathoms. *Ancilla fusiformis* Petterd (Plate xxxvi., f. 10) appears to be the name of the commonest form in the dredgings, occurring in 10-20 fathoms off Gabo Island, and in Disaster and Twofold Bays in the same depths, while one live and some dead ones occurred in the deepwater dredgings 50-70 fathoms off Green Cape, N.S.W., together with a fragment of a more heavily sculptured spire. A peculiarly elongate form (Plate xxxvi., f. 9) was dredged in 18 fathoms off Merimbula, and this agrees with the Challenger shell from Station 163 B (Port Jackson 30-35 F.), recorded by Watson as *A. oblonga* Sow. This I am not describing as a new species, though I find the Muddy Creek fossils in the British Museum named *Ancilla papillata* Tate are very like the shell I have determined as *fusiformis*, but differ a little in shape. The difference between the two recent forms above recognised is much more marked than between the recent and fossil forms from practically the same locality, as this species (*fusiformis*) apparently occurs also in Bass Straits; I have received it in a single dredging of 12 fathoms depth off Gabo Island, Vic. I here name the Merimbula shell figured (Plate xxxvi., fig. 9) *Baryspira fusiformis gaza*, n. subsp. In looking up these species in the Monographs I noted Reeve's remark: "Mr. Cuming never met with the genus in all his dredgings, except in the form of a single small species at the Philippine Islands." In the present instance these animals occur in very many dredgings, but never numerously, and often dead. Apparently they are generally buried in the sand as this is their custom when the dredge passes over, and they may feed at stated intervals. Upon recomparison, the deepwater shells above mentioned approximate more nearly to the fossils than the shallow water ones do.

More study of more material has suggested the separation of the Australian species subgenerically as *Alocospira* Cossmann (Essais de Paleoconch. comp., 3rd livr., 1899, p. 92) which has the fossil *A. papillata* Tate, as type, including therein the smooth species, such as *marginata* Lam. These appear to intergrade, though both are represented in the Muddy Creek and Table Cape fossil series, with many so-called species, which must be studied in conjunction with these recent forms.

(774-800) Family MARGINELLIDAE.

As usual, many species of this family turned up, about twenty-five species having been already separated. These were submitted to my friend Mr. J. R. Le B. Tomlin, and I had hoped to have included here a rearrangement of the Austral species into groups, so that someone, save a *Marginella* specialist, might attempt to determine the species without considering every Marginellid name. In the meanwhile, I can add to the N.S.W. List five species:

Marginella tasmanica Ten.-Woods, Papers Proc. Roy. Soc. Tasm., 1875 (21 Mar., 1876), p. 28: Long Bay, Tasmania. This was found below dead low-water mark at Twofold Bay, N.S.W., associated with *M. muscaria* Lam., while from 50-70 fathoms off Green Cape were sorted:

Marginella dentiens May, Papers Proc. Roy. Soc. Tasm., 1910, p. 384, Pl. xiii., f. 6: 100 F. off Cape Pillar, Tasmania.

Marginella gabrieli May, ib., p. 386, Pl. xiii., f. 9: Same loc.

Marginella gatliffi May, ib., p. 385, Pl. xiii., f. 8: 40 F. off Schouten I., Tas.

Marginella caducocincta May, ib., 1915 (24 Feb., 1916), p. 88, Pl. ii., f. 11: 40 F. off Thouin Bay.

(802) CANCELLARIA AUSTRALIS Sowerby, 1832.

The name given in the synonymy, *Cancellaria undulata* Sowerby, must be used, as May has already pointed out (Illustr. Index Tasm. Shells, 1923, Appendix, Ref. to Pl. xxxiv., No. 1). Sowerby's name was given to a Tasmanian shell, but the Sydney form does not appear to differ much from the specimens so far studied.

I hope to review the species of this family admitted in the southern Australian fauna, but in the meanwhile No. 805 must be removed from *Admete* back to *Cancellaria* sensu lato, and it must be given specific rank, as quite distinct from the fossil *micra;* the small specimens, compared by Hedley with the type of *micra,* may not be conspecific with the type of *scobina,* and I do not regard them as conspecific with the fossil *micra,* but very close to *exigua* Smith, which would be placed next to *stricta* Hedley, and arranged alongside some of the small fossils such as *micra.*

(813 A) TEREBRA USTULATA Deshayes, 1857.

Terebra ustulata Deshayes, Journ. de Conch., 1857 (July), p. 97, Pl. iii., f. 12: Van Diemen's Land. Mus. Cuming.

From Twofold Bay four species of *Terebra* were dredged in varying depths, but a single dredging in 10-20 fathoms in Disaster Bay brought up a hundred specimens of a different species, which has been determined as above and which is an addition to the New South Wales fauna. Later, an odd dead shell was found in Twofold Bay dredgings, so that it does reach that bay.

The species has been placed by May, following Hedley, under the genus *Duplicaria* Dall (Nautilus, 21, Mar., 1908, pp. 124, 125), provided for *Terebra duplicata* Lam. Dall later noted that Rafinesque had long previously proposed *Duplicaria* (Atlantic Journal, No. 5, 1833, p. 165) for a different object, so amended his name to *Diplomeriza* (Nautilus, 33, July, 1919, p. 32). Bartsch has recently shown (Nautilus, 37, 1923, pp. 60-64) that some of the so-called *Diplomeriza* have two folds on the columella, and has proposed to separate these under Hind's name *Myurella,* introducing *Myurellisca* for the species confused with Lamarck's *duplicata,* which he distinguished as *Myurella* (*Myurellisca*) *duplicatoides* (p. 64) from Ceylon.

Bartsch has written "Considerable time was required running down references to names and verifying type designations. To save future students of this task a chronologically arranged list of names supplying this information is here appended." Such a statement would suggest accuracy which is belied by the published conclusions. Thus Dall wrote *Acuminia* and *Oxymeris,* but Bartsch quotes *Acuminea* and *Oxomeris,* and on p. 63 he named, as type of his new subgenus *Myurellisca,* "*Terebra* (*Myurellisca*) *duplicatoides* Bartsch described below" but on the next page "*Myurella* (*Myurellisca*) *duplicatoides*" is described. Probably also this new (?) species has been named previously, as there are several synonyms. Again, Bartsch cites names as of Lamarck which had been described before Lamarck's time: this is confusing, but when he writes that the type of *Mazatlania* Dall is "*Terebra aciculata* Lamarck" and there is no such species, it seems unnecessary to continue this note, and simply to ignore Bartsch's Key, and make an independent review. This is not my purpose, but, in order to stabilise some Australian forms, I propose to separate the species grouped round *ustulata* Deshayes as a new genus *Pervicacia,* using that well-known species as type. There is only the basal twist of the columella to represent a fold.

The species *T. brazieri* Angas was represented at Twofold Bay by a longer

narrower form which varied from almost smooth to well ribbed (Plate xxxvi., f. 6-7), and would fall, according to Bartsch's Key, under *Hastula*, whereas the species has been suggested to be a variety only of *T. lanceota* Linné, the type of *Acuminia* Dall (Nautilus, 21, Mar., 1908, pp. 124-125), which name may be used generically for the Austral species. I note *Terebra leptospira* Tate (Trans. Roy. Soc. S. Aust., 1888, p. 163, Pl. viii., f. 15a, b) from Muddy Creek appears very close to *A. brazieri* Angas, while *Terebra subspectabilis* Tate (loc. cit., p. 162, Pl. ix., f. 11) seems closely related to *P. ustulata* Deshayes. Comparisons should be made.

(813 B) PERVICACIA ASSECLA, n.sp. (Plate xxxvi., f. 16).

Shell elongately subulate, rather thin, glossy, last whorl about one-third the length of the shell, mouth oval, canal short and open. Colour pinkish-white with fulvous spots below suture and darker fulvous on basal part of last whorl: sometimes suffused with fulvous throughout. Apical whorls two, smooth; adult whorls ten, sutures impressed, longitudinally ribbed, the ribs being interrupted by a smooth concave depression, sinuous and eighteen in number on the penultimate whorl: on the last whorl the ribs are prominent on the periphery, continuing, but fading, on the base which is rounded. The mouth has the outer lip thin, sinuate through the lack of sculpture below the suture, the columella straight, anteriorly a little bent but showing no folds. Length of type 28 mm., breadth 9 mm.

Dredged in Twofold Bay, N.S.W., in from 10-25 fathoms.

Superficially resembles *P. ustulata* (Deshayes), but I have seen no other Australian Terebrid that can be compared.

(823) CONUS MACULOSUS Sowerby, 1859.

A perplexing complex is here exposed, as Roy Bell sent a fine lot of so-called *anemone* from Port Fairy, Vic., where I have since collected it. Previously he had sent a similar species from Lord Howe Island and later sent a few specimens from Twofold Bay, N.S.W. I have collected specimens at Long Reef, near Manly, but these all differed notably and suggest to me a distinct species, though Hedley has only allowed them varietal rank. In any case the name to be used must be revised, and I find that *Conus maculosus* Sowerby dates from the Conchological Illustration, Pl. 3 and 3 *, published 29 Mar., 1833, where it is said to have come from the Island of Capul in the Philippines, and the figures are not like either the Port Fairy or Sydney shells. It is needless to pursue this item further, as the name is preoccupied by Bolten (Mus. Bolten, pt. ii., 1798). The next name cited by Hedley, viz., *C. jukesii* Reeve (Conch. Icon., Vol. i., Apr., 1848, *Conus* suppl. Pl. 2, f. 278) though localised as from North Australia is undoubtedly the Sydney shell, and would be available were it not that Sowerby had figured (Conchological Illustrations, pt. 56, 30 Apr., 1834, fig. 79) a shell (the figure numbered 70 in error) which is easily recognizable as the same species. In the Lists issued with the plates, Sowerby named this *Conus papilliferus*, and the name would have been lost, save that in the Catalogue issued when the Monograph was completed, he had noted that this name had been given, as he there concluded the figured shell was "*C. maculosus*, test. jun.?" In 1859, at the place cited by Hedley, Sowerby used the name *maculatus* for his previously named *maculosus*, whether intentionally or not is unknown. The majority of the specimens from Botany Bay to Port Stephens in the Australian Museum are typically *C. papilliferus*, but there is one set presented by Miss L. Parkes from Middle Harbour,

which are like the Twofold Bay shells. These agree with the Port Fairy series in general appearance and have lower spires and are smoother than the typical *anemone* Lamarck. Since Hedley wrote his account of this species, the Australian Museum has received specimens from Kangaroo Island, which agree most exactly with Kiener's figure (Coquilles Vivants, Conus Pl. 46, fig. 3) of Lamarck's shell. This leaves the name *Conus novaehollandiae* A. Adams for the Western Australian shell, as Monte Bello Island specimens agree very closely in shape and sculpture with the figures in Thes. Conch., sp. 268, f. 298-299.

May has figured (Illus. Index Tasm. Shells, 1923, Pl. xxxiv., f. 16), under the name *Conus anemone* as "common all round the coast," a shell which does not agree exactly with typical *anemone* and which may bear Tenison-Woods's name of *carmeli* (Proc. Roy. Soc. Tasm., 1876 (1877), p. 134: North Coast Tasm.) given to a coronate variety.

Brazier named *Conus remo* (These Proc., xxiii., 1898, p. 271) from San Remo, Vic., and *Conus flindersi* (loc. cit., xxii., 1897, p. 780) from Flinders, Vic., which Pritchard and Gatliff declare to be synonyms of this species, the latter being described as coronate and therefore like *carmeli*, the former being a deeply sulcated variation approaching typical *anemone*.

(885 B) TELEOCHILUS ROYANUS, n.sp. (Plate xxxiv., figs. 6-7).

This genus was proposed by Harris (Cat. Tert. Moll. Brit. Mus., Part I. (Austral Tert. Moll.), (publd. ante 25 Mar.) 1897, p. 64) for the fossil species, named by Tenison-Woods, *Daphnella gracillima* (Papers Proc. Roy. Soc. Tasm., 1876 (27 Feb., 1877), p. 106) from Table Cape, Tasmania. This was figured by Ten.-Woods (These Proc., iii., pt. 3, 1878 (1879), p. 226, Pl. xx., f. 10) and also by Harris (loc. cit., Pl. iii., figs. 12c, d). I picked out two dead shells inhabited by hermit-crabs, which attracted by their strange facies, "Conomitroid without any plaits." These are smaller than the fossil shells, but are obviously the recent representatives, in which the longitudinal ribbing is more pronounced and the spirals are more depressed, while they are less regular.

The apical whorls are minutely punctate (f. 7) as shown in Harris's figure, and the succeeding whorls are obsoletely longitudinally ribbed and transversely scratched, a couple of transverse ridges being more prominent below the suture, which is slightly canaliculate; the aperture is longer than the spire. Length 16 mm.; breadth 6.5 mm.

Dredged in 10-25 fathoms in Twofold Bay, N.S.W.

This is the most interesting species found by Roy Bell, and, until the animal is examined, its classification must remain obscure. As noted above, the only specimens I have seen were dead, but this may be the same thing as recorded by Gatliff and Gabriel from Bass Straits as *Daphnobela* sp., in which case live specimens may soon turn up.

The genus *Teleochilus* was subordinated by Cossmann, who was followed by Tate, to *Daphnobela*, a genus proposed for a Bartonian Eocene fossil, which seems to have no relationship. Hedley recently proposed to use *Teleochilus* for a different series of shells, about which I will write later. *Teleochilus* is here placed at the end of the family *Turridae*.

(886) FASCIOLARIA AUSTRALASIA (Perry, 1811).

This is a difficult species. Hedley has allowed three varieties, typical, *bakeri* and *coronata*. A series from Port Fairy, Vic., is of the smooth typical form,

and shows no variation, while a lot from Twofold and Disaster Bays, N.S.W., are all larger and *coronata,* but with these from Disaster Bay came a specimen quite different, and which I thought might be *bakeri,* but it does not agree exactly with shells sent to the British Museum by the authors as that form. I have since more carefully examined these series and give my conclusions as a basis for future work.

All the shells from Twofold and Disaster Bays were dredged in from 10-20 fathoms of water. No shore shells were sent, and the previous records of this species from New South Wales also refer to dredged specimens. All these are *coronata* save the *bakeri* specimen. From Lakes Entrance, Vic., a few dead shells were sent which prove to be also *coronata.* From Port Fairy many shells were sent, all secured living about low water mark and these are all obviously different, being non-coronate. In the British Museum, Tasmanian shells are shown as coronate, South Australian shells as non-coronate. Verco has stated that both coronate and non-coronate forms occur in South Australian waters, but as he did not discriminate between shore shells and dredged specimens, it may be that the former were like the Port Fairy shore shells, non-coronate, while all the coronate forms were dredged. Investigation of the subject from the point of view here presented is suggested. It should be noted that Lamarck's *coronata,* from Kiener's figure, is like the dredged New South Wales specimens, but is more like the Tasmanian shells, and while Perry's figure of *australasia* agrees fairly with the Port Fairy shore shells. Perry's localities read "A native of New Holland and Van Diemen's Land" while Lamarck recorded "près des iles King et des Kanguroos." I suggest a reconsideration of the forms should be undertaken in connection with the radular characters. Typical *Fasciolaria* is the North American *tulipa,* conchologically dissimilar from the present species. More like the Australian *coronata* is the tropical *trapesium,* for which Fischer proposed the sectional name *Pleuroploca.*

Over twenty years ago, Verco gave figures of the radulae of South Australian Fusoid shells, and recently Claude Torr figured the radulae of *Fasciolaria australasia* and *fusiformis* from South Australian material. These figures do not agree exactly with radulae in the Gwatkin Collection from Victoria and Tasmania, nor with specimens from the present collection. There is no series of such preparations to determine the variation and decide whether it be individual or geographic. All the Australian radulae agree in showing fewer cusps on the laterals than the typical *Fasciolaria* or *Pleuroploca.* As there is so little difference in the radulae seen in this group, that of true *Fusinus* being almost as little differentiated from typical *Fasciolaria* as the Australian species are, I am collecting information as to other species and hope to report in my next essay. I have also noted that there is a fossil *Fasciolaria decipiens,* a form not unlike *bakeri,* showing the plications very obscurely, so much so that the specimens here have been more than once variously determined.

My friend, Mr. J. R. Le B. Tomlin, has drawn my attention to a monograph of the genus *Fasciolaria* by Strebel in Jahrb. Hamburg Wissensch. Anstalten, xxviii., 1910, 2 Beiheft, (1911), pp. 1-58, Pls. i.-xv. Although Strebel apparently collected all the specimens he could find, there is nothing like the so-called *bakeri* in his series, nor does he figure a shell like the Port Fairy *australasia.*

Mr. Hedley has told me that apparently many of Perry's Australian shells came from Patterson (hence *Voluta pattersonia*), and that Patterson once lived at Dalrymple in northern Tasmania. This locality would agree with Perry's *australasia* and also his *Pyrula undulata* (see *post,* 891 A), as I find that the

Port Fairy shore shells are practically inseparable from King Island and northern Tasmanian shore shells.

South Australian shore shells of *coronata* are not exactly like the Tasmanian forms, and are unlike the smooth Port Fairy *australasia*.

(888) Verconella maxima (Tryon, 1881).

A fine series of this lovely shell from Twofold Bay and off Green Cape, N.S.W., showed it to be the Australian representative of the Neozelanic *dilatata*, and consequently suggested the invalidity of the record of *maxima* from New Zealand. I investigated this matter as far as the material here available permitted, and then Hedley recorded results from recognition of the same facts in New Zealand. In the N.Z. Journ. Sci. and Techn., iii., Feb., 1920, p. 54, he stated that Suter's *maxima* was the true *dilatata*, and that the species Suter had described under the name *dilatata* should be called *adusta* Philippi (Abbil. Beschr., ii., 1845, p. 21, Pl. ii., fig. 7). On p. 170 (Sept., 1920), he gave photographs of the species, but, unfortunately, the names in connection were transposed, but the correction was made on p. 222. The series here had previously enabled me to recognise the true *dilatata*, but I had concluded that the false *dilatata* was merely a shallower water form of the same species, being not so acutely angled, with a shorter spire and shorter canal. Verco has synonymised with *dilatata, tasmaniensis* Adams and Angas, *maxima* Tryon, and *oligostira* Tate. Hedley, in the note quoted, stated that *dilatata* did not extend to South Australia, the species there being *oligostira* Tate.

Two entirely different molluscs appear to be here confused as Tate's *oligostira* is not angled like *dilatata* and *maxima*, yet Verco has recorded, under the name *dilatata*, from the Great Australian Bight, specimens "with marked angulation, valid sharp transverse coronating tubercles" which suggests to me a form of *maxima*. The series of *maxima* I have studied vary in size from 20 mm. to 250 mm., and came from depths varying from 15 to 70 fathoms, yet all are quite constant.

Hedley inadvertently placed *Verconella* in the family Fasciolariidae, as the radula and animal characters separate it quite widely from the Fusinoid series.

(889) Fusinus novaehollandiae (Reeve, 1848). (Plate xxxiv., f. 9.)

Two very large specimens trawled in about 50 fathoms off Green Cape were typical, save that the inner lip was enamelled into a distinct ridge separated from the body-whorl and showing a small but distinct posterior canal. Both measured 225 mm. in length (one was broader, and the apex and canal were both slightly broken), and dead, so that alive it must have been larger. On the last three whorls of both the longitudinals were very weak, almost missing, and the whorls were all regularly rounded.

Many specimens were found with the animal in, on the shore at Disaster Bay, recently washed up, and many were dredged up to 20 fathoms in both this and Twofold Bay. The largest of these shallow water shells measured 180 mm. in length and none had the inner lip thickened, but the larger ones showed the thickening beginning anteriorly. This series showed variation in the longitudinals, some having these well marked almost throughout, others practically showing none throughout, but every one had regularly rounded whorls.

This suggests the reconsideration of Verco's record of this species from the

Great Australian Bight, as he states of his example: "67 mm. long . . . . shoulder is median and sharply angled with nine pliciform axial ribs."

Mr. Hedley has suggested that the large deepwater shells deserve a varietal name, and from examination of the series in the Australian Museum, which all agree with my specimens, I propose to name this *Colus novaehollandiae grandiculus*, n. subsp.

The generic name *Colus* was published by Humphrey (Museum Calonnianum, 1797, p. 34), the Linnean *Murex colus* being the type by tautonymy.

The legitimacy of Humphrey's names cannot be denied, by whatever rules we abide, as they are published as genera by a binomial author with a bibliographical reference. Anonymity is no bar to usage, and Humphrey's names were used for many years until quite recently.

(891) Fusinus waitei (Hedley, 1903).

A single specimen was forwarded from 50-70 fathoms off Green Cape, N.S.W., but it was obviously not a *Fusinus*, as it was accompanied by typical Fusinoid shells, determined as *F. novaehollandiae* Reeve, and showed more relationship with *Verconella maxima* (Tryon), but still representing quite a distinct group. As, at the same time as he proposed this as a species of *Fusus*, Hedley discussed *Verconella* under a different generic name, I can see little objection to my introducing the new generic name *Berylsma*, with Hedley's species *Fusus waitei* as type. My specimen contained a hermit crab, but Mr. J. R. Le B. Tomlin has showed me a smaller specimen from Bass Straits (off Victoria), named *F. waitei*. It shows the operculum, which agrees with that of *Verconella*, and differs from that of *Fusinus*, and apparently was dredged in fairly deep water, as it is rather thin and pure white, covered with a thin silky periostracum, and bolder sculpture than my shell. I have concluded, from prolonged study, that this is merely a deeper water representative of the shell described by Adams and Angas as *Fusus tasmaniensis* (Proc. Zool. Soc. Lond., 1863 (1864), p. 424, Pl. xxxvii., fig. 1) from Tasmania. The type is in the British Museum and agrees very closely with Hedley's species, save that it is shorter in the spire and has a shorter canal. Alongside were placed specimens which seemed conspecific, but which were labelled "*grandis* Gray" and "Tasmania." This meant they were from unknown locality, but had been determined by Smith from comparison as *grandis* Gray, and that he had seen specimens from Tasmania. I was fortunate in tracing the Tasmanian shell sent by Roland Gunn, and still more so in finding, in a drawer of duplicates, a shell with a paper inside stating "This is the type of *Fusus grandis* Gray" in Smith's handwriting. Inside the mouth of the shell in Gray's handwriting is the identification "*F. grandis* Gray, Coll." The photograph, natural size, I had at once taken shows that this species is certainly *tasmaniensis* and differs from *waitei* only in the shorter spire and canal. Otherwise the photo of *grandis* (Plate xxxv., f. 10) agrees in detail with my specimen of *waitei* as to breadth and ornamentation. *Fusus grandis* was described by Gray (Zool. Beechey's Voyage, (after June), 1839, p. 116) from unknown locality, and does not seem to have been used since, save in the cases in the British Museum.

I find that Mr. Hedley has recognised the affinity of his species with the Verconellids, beautiful specimens recently acquired being labelled in the Australian Museum, *Verconella waitei*. The specimens from deeper water, say 70 fathoms, agree with the type, which was secured at a depth of 79-80 fathoms,

while shells from less depths, say 40-50 fathoms, agree better with my shell, that is, they are broader, with a slightly shorter spire and canal, more solid, sculpture less pronounced and are tinged with colour of a yellowish tone. These are quite comparable with both *grandis* and *waitei*, and strongly support my conclusions recorded above.

(891 A) PROPEFUSUS PYRULATUS (Reeve, 1847).

When Hedley reviewed Perry's Conchology (These Proc., 1902, p. 24 et seq.) he recorded (p. 27) "*Pyrula undulatus*, Perry (Pl. liv., f. 1), is *Fusus pyrulatus*, Reeve, 1847."

Pritchard and Gatliff, under the latter name, had lumped *Fusus ustulatus* Reeve, writing "Making the same variation allowances as have been found necessary in the case of many of our other species, we find that we cannot do otherwise than regard *F. ustulatus*, Reeve, as but a variation of *F. pyrulatus*, Reeve, and *F. legrandi*, T. Woods, must also be included in the synonymy."

Verco had previously recorded *F. pyrulatus* Reeve as dredged in about 15 fathoms in South Australian waters, and *F. ustulatus* Reeve as from three beaches and also dredged, small, in 19-24 fathoms. Tate and May later recorded *F. pyrulatus* Reeve from Circular Head, common, and *F. ustulatus* Reeve, of which they regarded *F. legrandi* Ten.-Woods as a synonym, from N. Coast and E. Coast of Tasmania. Pritchard and Gatliff admitted Hedley's recognition of Perry's name. Hedley does not quote either from Western Australia, nor have I seen it recorded from New South Wales.

Shore shells sent by Roy Bell from Port Fairy, Vic., were determined as *F. ustulatus* Reeve from the type specimens, but these appeared distinct from *F. pyrulatus* Reeve, as shown by the types. Later, Bell dredged specimens from 10-20 fathoms in Disaster Bay, N.S.W., and later some young ones in Twofold Bay, about the latter depth. These obviously differed from the Port Fairy ones, and agreed with the types of *pyrulatus* Reeve. I then referred to Perry's Conchology, and found that his *Pyrula undulata* (Pl. liv., No. 1) was exactly like the Port Fairy shells, and was not the New South Wales form. The differences in the types and in my shells are clear, the dredged shell being larger and thinner and having a longer bent canal. The radula has been recorded as Fusoid, so I propose for the species *Fusus pyrulatus* Reeve, the new generic name *Propefusus*, as the shell-characters are unlike those of the true *Fusus*, i.e., *Fusinus* = *Colus*.

(904) MICROVOLUTA AUSTRALIS Angas, 1877.

A common shell in shallow water dredgings appeared in two colour variations, one dark red-brown monochrome, the other pale fawn with brown zigzag streaks. A third distinct form had a longer spire and stronger sculpture, though similarly coloured to the latter. This was dredged in the deeper shallow water of Twofold Bay, say from 15-25 fathoms, and dead shells in the 50-70 fathoms, off Green Cape.

Hedley and May (Rec. Austr. Mus., vii., 11 Sep., 1908, p. 120, Pl. xxiii., figs. 20, 21) named as a new species, from 100 fathoms, 7 miles east of Cape Pillar, Tasmania, *Microvoluta purpureostoma*, "Distinguished by lack of colour, feebler plaits, smaller size and less breadth. Two specimens, one 6 x 3 mm., the other 8 x 3.5 mm." They added "The characters seem to us to incline to the Mitridae rather than to the Volutidae." The majority of the monochrome specimens would answer to this as regards shape and size, etc., and probably the

Tasmanian specimens were dead and were pallid deeper water shells. From shell-characters, I agreed with Hedley's reference to the Mitridae, and could not understand the reference to the Volutidae. The only fear I had in connection with the new species I am describing, is, that it might have been described as a species of *Mitra*. As all the specimens of the common form were live shells, I handed some to my friend, Lt.-Col. Peile, for radular examination. There is no operculum, but the radula turns out to be typically Volutoid, practically a miniature of that of *Scaphella undulata,* which was examined at the same time.

Smith described a *Mitra miranda* (Proc. Zool. Soc. Lond., 1891) from Challenger Station 164 B, which, from the description and figure, is a *Microvoluta,* but is not my new species. I have examined the figures and descriptions of the Muddy Creek *Mitra,* but cannot recognise anything like this species, but some of these figures suggest *Microvoluta,* and actual comparison is necessary.

(904 A) MICROVOLUTA ROYANA, n.sp. (Plate xxxv., f. 13.)

A deeper water relation of *M. australis,* differing in the longer spire and complex sculpture.

Shell small, solid, shining, fusiform, spire a little attenuate, longer than aperture, outer lip sinuate, contracted anteriorly. Colour pale fawn with undulating zigzag streaks of pale red, and scattered darker red spots arranged linearly, and a paler zone marking the periphery. The apical whorls are unsculptured, one and a half in number, but can scarcely be said to be papillary, as in the type. The sculpture consists of curved, longitudinal, ill-defined ribs with shallow grooves between, about twenty-four on the penultimate whorl, and more on the last whorl, becoming obsolete and crowded towards the outer lip: they are less clearly differentiated on the earlier whorls, only showing as impressed lines on first whorl succeeding apical one and a half. All the whorls are completely crossed by thin incising lines almost as irregularly spaced as the longitudinals, about seven on penultimate whorl, those succeeding suture closer together, more separated towards base, about twenty-four lines on last whorl. There are about six and a half sculptured whorls, convex, with sutures distinct. Outer lip thin and sinuous, but solid, a shallow depression posteriorly, succeeded by a forward curve below the middle and sharply retracting anteriorly into a shallow spout. There are four well marked plications, regularly transverse, the first and third prominent, the second more so, and the fourth least and anteriorly sloping. Length of type 9.5 mm.; breadth 4 mm.; length of aperture 4.5 mm.

Dredged in the deeper water in Twofold Bay, N.S.W., 20-25 fathoms, and also in 50-70 fathoms off Green Cape, N.S.W.

Compared with numerous specimens of *M. australis* Angas from 5-15 fathoms in Twofold Bay, the coloration is similar, but the aperture in the type species is equal to the spire, which is a little compressed, the whorls less convex, sutures only impressed; the plications in the shallow water form are less marked, fourth obsolete, the outer lip almost straight, no posterior depression, and the anterior contraction not so pronounced. The genotype shows no sculpture, but really there is a couple of incised lines just below the suture, and in the earlier whorls faint indications of the lines longitudinally can be traced.

(904 B) PECULATOR VERCONIS, n. gen. et sp. (Plate xxxiv., f. 5.)

A close ally of *Imbricaria porphyria* Verco, and probably the Peronian representative of that species, differing in the higher spire and stronger sculpture.

May (Illustr. Index Tasm. Shells, 1923, Pl. xxxvii., fig. 23), under Verco's name, has figured a species very similar to, if not the same as mine. Verco's detailed description agrees generally as regards shape and form. Shell ovate, spire short, aperture long and linear, more than twice the length of the spire. First two whorls smooth and rounded; rest sculptured with longitudinal ribs, of which twenty-three can be counted on the penultimate whorl, a transverse sculpture of closely-packed incised lines being observed between the ribs; the same sculpture is seen on the last whorl, but the transverse sculpture becomes obsolete below the periphery, while the ribs also become weaker as they approach the anterior canal, where the transverse sculpture becomes more prominent again. Coloration pinkish-white with orange spots below the suture and below the periphery, the intervening space being marked with yellow arrow-head markings. Length 11 mm.; breadth 6 mm.

Dredged in Twofold Bay, 15-25 fathoms; and also in Disaster Bay, N.S.W., 10-20 F.

(910 A) Radulphus royanus, n. gen. et sp. (Plate xxxiv., f. 8.)

Nearest *Cyllene lactea* Angas, but different at sight in sculpture and colour.

Shell small, buccinoid in shape, aperture about as long as spire, aperture oval, open, canal shallow, spire narrowly triangular. Coloration pinkish-fulvous, rather regularly spotted with white, the spots most noticeable on the last whorl. Apical whorls two, mamillate, smooth; adult whorls six, sculptured on the earlier whorls with longitudinal ribs, faintly at first, then strengthening to the antepenultimate whorl, where they decrease at the suture and develop into nodules peripherally; on the last whorl the sculpture appears to consist of a peripheral row of nodules extending a little anteriorly, succeeded by eight transverse lines; a shoulder shows only growth lines, but on the earlier whorls a few transverse lines may be observed. The inner lip is concave, appressed on the columella anteriorly and showing about eight transverse wrinkles; the outer lip is white, sharp edged but thickened interiorly, a few wrinkles anteriorly only, sinuate a little past the middle and advancing posteriorly. Operculum leaf-shaped. Length 15 mm.; breadth 7 mm.

Dredged in 15-25 fathoms in Twofold Bay, N.S.W., also in Disaster Bay, 10-20 fathoms.

(929) Nassarius semigranosus (Dunker, 1846).

Dunker described this under the genus *Buccinum*, and previously Wood (Index Testac., 1828, Suppl. p. 11) had proposed the same name, so that Dunker's name must be rejected. The next name seems to be *nigella* Reeve (accepted by Hedley for a variety). This species was common in the shallow water dredgings, varying appreciably, and the form named *munieriana* Crosse and Fischer was plentiful. This was ranked as a monstrosity by Hedley in his review of this species, but it seems to be a normal state, produced by growth after a long rest period.

The species does not seem distantly related to the Victorian shell I named *victorianus*, and I was inclined to refer some specimens to that species at first sight. Among the Muddy Creek fossils in the British Museum, I saw a series labelled *Nassa crassigranosa* Tate, which suggested themselves as ancestral relatives of both these recent species.

(929 B) NASSARIUS TASMANICUS (Ten.-Woods, 1876).

According to Hedley's figure, and more recent autoptic examination of typical specimens, Tenison-Woods's *Nassa tasmanica* occurs. This was described (Proc. Roy. Soc. Tasm., 1875 (1876), p. 150) from the northern and eastern coasts of Tasmania, and was figured by Hedley (These Proc., xxxix., pt. 4, 1914 (26 Feb., 1915), p. 737, Pl. lxxxiv., f. 91). In the very shallow rock scoopings, many specimens were found from Twofold Bay, mixed with the preceding, but the latter was only dredged very commonly in depths from five fathoms down to the 50-70 fathom dredgings. In the latter a number of specimens was found, and as some were alive, *nigella* apparently lives down to that depth. The series showed that it was rapidly decreasing in size, the largest specimens being only equal to the average of the smaller of the shallow water series, being about half the size of the larger ones.

(935) PYRENE BEDDOMEI (Petterd, 1884).

This species was described as a *Terebra*, while it had been otherwise named *Columbella attenuata*. The attenuate form amply distinguishes the species from *Pyrene*, while the shape of the mouth is very different, the inner lip being crenulate and the outer lip sinuate; operculum irregularly oval, apex terminal, concentric striae fairly well marked. I propose the new generic name *Zella* for this species.

(971) CRASPEDOTRITON SPECIOSUS (Angas, 1871).

It seems correct to propose a new generic name, *Galfridus*, for this species, as it is obviously not congeneric with the type of *Craspedotriton*, *Triton convolutus* Broderip, when a careful examination of the shells is made. The latter has a long spire, which is commonly decollate, and a closed canal, and the resemblance is quite superficial. Moreover, we have knowledge of the radula and opercular features of the Australian shell, while we do not yet know details of *Craspedotriton*. The operculum and radula of *speciosus* Angas were figured by Kesteven (These Proc., 1902, p. 479, fig. 3 in text). Further, prior to Dall's proposal of *Craspedotriton*, Canefri had introduced (Ann. Soc. Malac. Belg., xv., 1880 (1881), p. 44) the name *Phyllocoma* for *convolutus* alone. This is antedated by *Phyllocomus*, proposed by Grube in 1877, and, according to our usage, invalid, but Bartsch, e.g., might not at present accept our views.

(974) LATAXIENA IMBRICATA (Smith, 1876).

Smith called this species *Fusus imbricatus*, and an earlier Smith had used the same name (Geol. Trans., vi., 1841, p. 156) for a different fossil. Apparently the unlovely name, *Lataxiena lataxiena* Jousseaume, 1883, must be used.

(975) TYPHIS PHILIPPENSIS Watson, 1886. (Plate xxxiv., fig. 10.)

This species was dredged as a very fine form in all depths from 15-25 fathoms in Twofold Bay, Disaster Bay and off Merimbula, N.S.W. It was described from Port Phillip, Vic., and Pritchard and Gatliff record, from that locality also, *yatesi* Crosse. From specimens in the British Museum sent by Verco, I conclude that the latter is the Adelaidean representative of the Peronian *philippensis*, and, if both should occur, it would be most interesting, but I think it will be found that only one species lives there. The operculum and radula are normal.

In the Rev. Mag. Zool., 1879, Jousseaume published a division of the Muri-

cidae, and I recorded the names (Trans. N.Z. Inst., xlvii., 1914 (12 July, 1915), p. 469), but only those of *Murex* sensu latissimo, and not those of *Typhis*. I here give the latter, and make correction as follows: The number of the Rev. Mag. Zool., 1879, did not appear until 1882, so Jousseaume published a digest in Le Naturaliste, 2nd Yr., No. 42, 15 Dec., 1880, simply giving the names of the divisions and designating a type. As a coincidence leading to confusion, the pagination in Le Naturaliste is 335-6, while in the Rev. Mag. Zool., 1879, the pages number from 322 to 339. The Muricoid names in Le Naturaliste all appear on p. 335, as they are given in my paper quoted, with the same types, but two names are mis-spelled, *Gracilipurpura* and *Pterochilus*.

The names relating to the subdivision of *Typhis* read in Le Naturaliste as follows:

p. 335	*Typhis* Montfort.	Type *Murex tubifer* Brug.
	Typhinellus nov.	*Typhis sowerbyi* Brod.
	Typhina nov.	*belcheri* Brod.
	Siphonochelus nov.	*avenatus* Hinds.
	Typhisopsis nov.	*coronatus* Brod.
	Haustellotyphis nov.	*cumingi* Brod.
336	*Perotyphis* nov.	*pinnatus* Brod.
	Lyrotyphis (ex Bayle MS.) nov.	*Typhis cuniculosus* Düchstel (fossil).
	Hirtotyphis (ex Bayle MS.) nov.	*horridus* Brocchi (fossil).

In the Rev. Mag. Zool., 1879, which appeared in 1882, I find

p. 337	*Cyphonochelus* nov.	Type *Typhis arcuatus* Hinds.
338	*Pterotyphis* nov.	*pinnatus* Brod.

as corrections for *Siphonochelus* and *Perotyphis*.

Then are added

p. 338	*Talityphis*	Type *Typhis expansus* Sow.
339	*Trigonotyphis*	*fimbriatus* A. Ad.
	Typhisala	*grandis* A. Ad.

Examination of the series in the British Museum shows that the Australian *philippensis* is so like *belcheri*, i.e., *cleryi*, that the specific name has been used for it and is therefore referable to *Typhina*, but these are very close to the fossil, which is the type of *Typhis*. In the same way *sowerbyi*, *grandis*, *fimbriatus*, probably with *pinnatus* and *coronatus* (shown only by imperfect specimens) group together, though their distribution is eccentric. However, the generic distinction of the *arcuatus* group cannot be denied, and apparently *Cyphonochelus* must be used; the name *Siphonochelus* can only be construed as a *nomen nudum* as the type name was mis-spelled *avenatus*, and could not be recognised. The Muddy Creek fossil *Typhis mccoyi* Ten.-Woods seems to differ only by being larger than my series, while these are larger than the type. Verco has also recorded large specimens of *yatesi*, so that we have here an interesting series. A deepwater dead shell from 50-70 fathoms, off Green Cape, N.S.W. (it may have washed down) proved very close to the fossil form, as shown here by a smaller specimen than the type. *Typhis hebetatus* Hutton, a Neo-zelanic fossil, has even been regarded as synonymous with *T. mccoyi*, but this determination should be re-investigated.

I here name the large form I have figured (Plate xxxiv., f. 10) *Typhis philippensis interpres*, n. subsp., though it might as well be named *Typhis* [*mccoyi*] *interpres*, either nomination suggesting its relationship.

(976) Typhis syringianus Hedley, 1903.

The generic name *Cyphonochelus* should be used for this species, as cited in the preceding note. This beautiful little shell was dredged alive in small numbers in the shallower waters of Twofold Bay, from 6 to 12 fathoms, and achieved a length of 11 mm., and is of a red-brown colour when alive, sometimes with a paler zone circling the body-whorl. The operculum and radula are normal. Dead specimens from 50-70 fathoms off Green Cape are smaller.

(978) Xymene hanleyi (Angas, 1867).

This species ranges into Victoria, having been sent from Mallacoota by Roy Bell. It is not uncommon in the shallow water dredgings from Twofold Bay, and is always easily separable from *paivae,* with which it was confused until Hedley separated them comparatively recently. The Mallacoota shells are sometimes broader, but from Port Fairy, Vic., *paivae* was sent as a shore shell, and with it an elate similar-looking shell which was quite distinct, and may be one of the named forms commonly ranked as synonyms, such as *assisi* Ten.-Woods.

The genus *Xymene* cannot include these Muricoid forms, so I again propose a new genus, *Bedeva,* and name Angas's *Trophon hanleyi* as type.

I note that the dredged Twofold Bay shells have a longer, more recurved canal than the more littoral ones from Mallacoota, and this suggests that *paivae* is only the Adelaidean shore representative of the shallow water Peronian *hanleyi,* while *assisi* is the shallow water Adelaidean form. A pretty problem is here revealed.

(980) Thais succincta (Martyn, 1784).

Some of the commonest species of marine molluscs give the most trouble. For a century the question of the variability of the present species has been discussed, and the matter to-day cannot be regarded as definitely settled. Recently, Australian malacologists have accepted the specific identity of the two forms commonly known as *succincta* and *textiliosa.* I have collated the following expressions of published opinion in the known range of southern extra-tropical Australia and New Zealand. Tate and May included *P. succincta* and var. *textiliosa* without comment: years later, when May recorded *Thais succincta* Mart. from the Furneaux Group he noted "A smoothish form was seen." Pritchard and Gatliff wrote "There seems to be no doubt whatever, that *P. succincta* and *P. textiliosa* are but variations of the one species. The nature of their habitat probably controlling their variations to a great extent. The finer ornamented form is the commoner with us." Years ago, Verco wrote "the form . . . . having strong revolving ribs with excavated sides, is very rare on the South Australian coast. . . . . *P. textiliosa* Lam. is only a variety of *P. succincta,* and this is a very common shell here. From a large number of specimens we have been able to obtain complete series of gradations between *P. succincta* and *P. textiliosa,* and between *P. textiliosa* and *P. aegrota,* proving them all to be but variations of a common species."

At Sunday Island in the Kermadec Group, this form was probably living, but was only met with as a huge dead shell, which has since been considered as a distinct species. In New Zealand, both forms appear to live in the North Island and Suter states that the smoother form is the more common, with the suggestion that the differences are due to habitat. At Caloundra, Queensland, I collected a series which showed both forms, under the same conditions, and the *succincta* form was constantly a thinner shell with the outer lip thin, the *texti-*

liosa form being much heavier and thicker and having a thickened lip, lirate within. Roy Bell sent me, from Norfolk Island, a long series from the same reef showing similar differences, and, moreover, very constantly so. Dr. A. H. Cooke got together a large series of shells from Australia, confirming Verco's suggestion, but emphasized the fact that the *succincta* form was the preponderating eastern Australian shell, the *textiliosa* the South Australian and the *aegrota* form Western Australian. He showed these at a meeting of the Malacological Society of London, when I confronted them with the above-mentioned facts and specimens, and he allowed that these created a difficulty. I suggested that only two solutions seemed possible, sexual dimorphism, or that there were two distinct species. He then studied the radulae of the whole of the species referred to *Thais* and published his results (Proc. Malac. Soc. Lond., xiii., Apr., 1919, pp. 91-109) wherein he showed that two types of radula were seen in the Gwatkin collection under the name of *textiliosa* and *succincta*, and that these suggested two species.

Roy Bell sent a nice series from Port Fairy, Vic., which were at once recognised as distinct from the Caloundra shells, as they were all smoothish *textiliosa*, but with lower spires and indistinct noduling at the shoulders, recalling *aegrota*. I have noted such a specimen in the British Museum, labelled *ventricosa* Tate. From Mallacoota, a good lot was sent, but these were nearly all typical *succincta*, a couple of odd shells like the Port Fairy series standing out at once. From Twofold Bay, a long selection was forwarded, every one of which was typical *succincta*. I then examined the radulae in the Gwatkin collection, and found that all those referred to as *textiliosa* were from Western Australia and Victoria, while the *succincta* specimens were from New South Wales. From this it is seen that the exact status of the New South Wales *textiliosa* is still undetermined, but that *aegrota* and its var. *ventricosa* are readily separable, either by shell characters or by radular features. I have studied this species on the Sydney beaches, with the result that, so far, all the specimens are easily referable to *succincta* alone, no *textiliosa* occurring, any apparently smoothish shell being traceable to fracture. From southern Tasmania, a series has been examined, all being *textiliosa*, and suggesting that the type of Lamarck's *textiliosa* may have been collected in that locality. The Port Fairy shells, which should geographically agree with Kangaroo Island ones, are not so well in agreement with the Lamarckian figure.

The New Zealand shells, regarded as *succincta*, are easily separable, and should bear the name *scalaris* Menke (Verz. Conch. Samml. Mals., 1829, p. 33), unless that name be preoccupied, which I have not yet determined. Since I recognised this fact and name, I find that Mr. Hedley had named the specimens in the Study Collection in the Australian Museum, selecting Menke's choice, as of varietal rank, so that the radula should be examined comparatively.

(981) AGNEWIA PSEUDAMYGDALA (Hedley, 1903).

The reference of this species to *Agnewia* is a pure error, as *Cronia* had been introduced earlier by H. and A. Adams (Gen. Recent Moll., Vol. i., Aug., 1853, p. 128) for *amygdala* Kiener alone. The shell from the eastern coast of Australia was separated as a distinct species from *amygdala* Kiener, from Western Australia, under the name *pseudamygdala* by Hedley. When I collected the shell known as *Drupa chaidea* Duclos at the Kermadec Islands, its close resemblance to the Australian shell impressed me, and I worked out the affinities of these shells from conchological characters, and accepted *Morula* for the *chaidea*

series. Cooke investigated the radula of these groups and published his conclusions (Proc. Malac. Soc. Lond., xiii., Apl., 1919, p. 91 et seq). Some of his statements are not exactly well-written, as in this case, dealing with the radula of the present species, he writes under the name "*Cronia amygdalus*, Kien.: Torres Str., Port Jackson. . . . . Mr. Hedley, I am told by Mr. Iredale, names *Cronia* from these localities *pseudamygdalus*, restricting *amygdalus* to Sydney and the east coast." This last sentence is ridiculous.

However, Cooke pointed out that the radula was "markedly that of *Morula*. *Cronia* is a scarcely modified *Morula*," thus absolutely confirming my conclusions achieved from conchological studies. In the same place, Cooke figured the radula of *Agnewia tritoniformis* (Blainville), which is of an entirely different pattern, being very close to that of the *succincta* series, for which I proposed the genus *Neothais*. Cooke further showed that the peculiar radular characters of *Lepsiella* were to be seen in the Australian species I ranged therein from shell features.

As noted above, I studied this group so may here note that the shell named by Hedley *Thais ambustulata* was collected by myself at Caloundra, Queensland, and seems to be closely allied to *margariticola* Broderip, a widespread tropical *Morula* of Muricoid facies.

In this family I suggest a renomination thus:

No. 979	*Thais ambustulata*	to be	*Morula ambustulata*
980	*succincta*		*Neothais succincta*
981	*Agnewia pseudamygdala*		*Cronia pseudamygdala*
988	*Drupa chaidea*		*Morula nodulifera*
989	*marginalba*		*Morula marginalba*

In the Proc. Malac. Soc. Lond., xiii., 1918, pp. 38-39, I noted that Duclos' *P. chaidea* was regarded by Martens, from study of the type, as identical with *P. nodulifera* Menke. This was briefly described (Verz. Conch. Samml. Malsburg, p. 33 (pref. May 18) 1829) without definite locality, but as the species is unmistakable, Menke's name may be accepted. At the same time, I recorded that *Purpura granulata* Duclos (Ann. Sci. Nat. Paris, xxvi., May, 1832) was equivalent to and earlier than *P. tuberculata* Blainville (after June, 1832), and this chronological item was overlooked by Hedley (These Proc., xlviii., 3 Oct., 1923, p. 314) when he gave a definite Australian locality for *Drupa tuberculata*, recte *Morula granulata* Duclos, a common shell at Lord Howe and Norfolk Islands, whence Bell sent it.

(1000) Siphonaria virgulata Hedley, 1915.

Hedley described this species from Terrigal, Sydney, and Twofold Bay, citing as equivalent *Siphonaria funiculata* Angas, not Reeve. His type measurements read: Length 21; breadth 19; height 9 mm. His comparison with *funiculata* reads "the Tasmanian species differs in being more solid, narrower, taller, with sharper contrast between light and dark stripes, and fewer coarser radials." He regarded *blainvillei* Hanley as an elevated form of *S. virgulata*. I have repeatedly criticised the British Museum types named, and agree in the above differential features, and have concluded that *virgulata* is simply the Peronian form of *funiculata* Reeve. Shells from Long Reef, Sydney, sent by Hedley as "Co-types" are seaworn and apparently smoother than shells from Victoria labelled "*inculta* Gould," which, of course, they are not. A very fine lot from Twofold Bay, sent by Roy Bell, are all very clean beautiful shells and agree generally with the description given by Hedley, and are undoubtedly his species.

From Mallacoota and Lakes Entrance, Vic., Bell had previously sent the

same species in the same clean condition, but a slightly rougher form. From the latter place, three large beautiful shells were sent, narrower and taller, and proving the exact relationship of *virgulata* and *funiculata*, as they agreed exactly with the types of the latter species save in solidity and less coarse radials.

Hedley, however, also wrote "Nearer to our novelty than *funiculata* is *S. zonata* Ten.-Woods (Proc. Roy. Soc. Tasm., 1877 (1879), pp. 47, 99), which is taller, narrower, darker in colour, more coarsely and evenly sculptured, and ranging from Tasmania to Victoria, and South Australia, being the Adelaidean correspondent of the Peronian *virgulata*." This statement has continually puzzled me, as from Port Fairy, Vic., Roy Bell had sent a beautiful series of probably the most pleasing *Siphonaria* I have seen. This was named in the British Museum Collection "*zonata* Ten.-Woods," and I found, at the reference above cited, that Tenison-Woods had previously described the shell as *Siphonaria denticula* var. *tasmanica*. This was pointed out by Hardy (Papers and Proc. Roy. Soc. Tasm., 1915, p. 62) in a paper I did not see until after I had traced this myself. Tenison-Woods described his species as "with 40 to 50 fine flattened and diminishing ribs," which agrees with Hedley's "sculpture," but the Port Fairy shells do not show "coarse" sculpture, being comparatively the "smoothest" form of *Siphonaria*, while the Lakes Entrance shell is even smoother. The name of the species known as *Siphonaria zonata* must become *Siphonaria tasmanica*, both of Tenison-Woods, an item overlooked by May (Check List; and also Illustr. Index Tasmanian Shells).

(1001) SIPHONARIA ZEBRA Reeve, 1856.

Hedley has admitted this name, apparently on account of the recognition of shells, apparently types, so named in the British Museum. These were localised as from "Port Jackson" and placed next to a set of "*bifurcata* Reeve," also apparently types, and also with locality "Port Jackson." As Reeve's species *zebra* was described from the Philippine Islands, I examined these in connection with the description and figure. Only a figure of the inside was given, and the description of *zebra* states "depressly conical . . . . white with one or two blotches," whilst of *bifurcata* was written "very depressly conical . . . yellowish white, interstices between the ribs rayed with black." The latter account agrees with the shells labelled *zebra*, while the set labelled *bifurcata* disagree entirely, as their outer surface is nearly unicoloured white, and they are comparatively very tall. I did not recognise them as the types of *zebra*, which I did not absolutely find. It will be noted that the figures have the numbers transposed, or it may even be that it was the descriptions which were mixed up. However, though it is certain that the two shells have been confused, I cannot recognise in anything I have seen, such a shell as Hedley might have determined as *bifurcata*. The real *bifurcata* (i.e., *zebra* Hedley), I conclude, is the Peronian representative of the Western Australian *baconi*.

(1002) KERGUELENIA STOWAE (Verco, 1906).

Many dead shells occurred in shell-sand sent me by Dr. Torr from South Australia, and the shells I sorted out of the shell-sand and shallow water dredgings from Twofold Bay, N.S.W., showed appreciable differences. The latter were more regularly elongate and smooth, and with the apex more anterior. I find these to be common and constant on the Sydney beaches, and I separate them subspecifically, but the genus *Kerguelenia* should first be rejected. The radula is very different, consisting of 120 rows with a formula of 44.1.44 in the case of

Kerguelenia lateralis from New Zealand, i.e., *K. innominata* Iredale; in *S. stowae* Verco, the rows are given as 94 with a formula of 22.1.22, a very different style. I introduce the new generic name *Pugillaria* for *S. stowae* Verco, and name the Peronian form *Pugillaria stowae comita*, n. subsp.

(1003) GADINIA CONICA Angas, 1867.

Some years ago, discussing the occurrence of a *Gadinia* at the Kermadecs, from a study of shell characters, I was compelled to lump all the Neozelanic and Austral forms into one species. Lumping is notoriously a bad policy, and in the few instances I have hitherto adopted such I have later been forced to alter my conclusions and this case points a special moral. Dr. Torr sent me some shell-sand from Port Lincoln, S. Aust., and from it I sorted some young dead shells of a *Gadinia*: these attracted me by their regular elongate shell, the shells I had previously studied being more or less circular with only slight eccentricity. I, therefore, reviewed the matter and concluded that the only way to criticise these molluscs was geographically, and, therefore, I contrasted my own series collected at Sydney, with the South Australian shells, and found them abundantly distinct, the former always being more rounded and flatter. Knowing the individual variation well, I was still certain that these were separable. Contrasting the former with Neozelanic specimens, the differences were not so striking, but still there were some. Recourse to the radular features showed great distinction: thus, Claude Torr counted thirty laterals in connection with that of the South Australian form, while Hutton found sixty in the New Zealand form. The radula in the Gwatkin Collection from Port Jackson shows about forty, but as I collected the Sydney shell alive myself, I am having some more preparations made, and will refer again. The anatomy of the Neozelanic species was dealt with by Hutton (Trans. N.Z. Inst., xv., 1882 (1883), 144).

Siphonaria albida Angas (Proc. Zool. Soc. Lond., 1878, p. 314, Pl. xviii., figs. 14, 15), described from St. Vincent's Gulf, S. Aust., is undoubtedly only a fine clean regular *Gadinia*; no such shape would be found in New South Wales.

(1123 A) PHILINE COLUMNARIA Hedley and May, 1908.

Philine columnaria Hedley and May, Rec. Austr. Mus. vii., No. 2, 11 Sep., 1908, p. 123, Pl. xxiv., figs. 25, 26: 100 fathoms, off Cape Pillar, Tasmania.

Specimens agreeing well with the description and figure of this species were found in the 50-70 fathom dredgings off Green Cape, N.S.W., and this species may be added to the N.S.W. List.

EXPLANATION OF PLATES XXXIII.-XXXVI.

Plate xxxiii.

1. *Neotrigonia gemma* Iredale, Type.
2. *N. margaritacea* (Lamarck), juv.
3, 4. *Myadora subalbida* Gatliff and Gabriel. 3. left valve; 4. right valve.
5, 6. *M. royana* Iredale, Type. 5. left valve; 6. right valve.
7, 8. *Fluctiger royanus* Iredale, Type. 7. right valve; 8. left valve.
9, 10. *Myadora complexa* Iredale, Type. 9. right valve; 10. left valve.
11, 12. *Bathycardita raouli* Angas. 11. adult; 12. interior view.
13, 14. *Myadora albida* Ten.-Woods. 13. left valve; 14. right valve.
15. *Solamen rex* Iredale, Type.

Plate xxxiv.

1-4. *Lima nimbifer* Iredale. 1. narrowed right valve, inside; 2. Type, side view; 3. full left valve, interior; 4. Type, outside of left valve.
5. *Peculator verconis* Iredale, Type.
6, 7. *Teleochilus royanus* Iredale, Type. 7. protoconch.
8. *Radulphus royanus* Iredale, Type.
9. *Colus novaehollandiae grandiculus* Iredale, protoconch.
10. *Typhis philippensis interpres* Iredale, Type.
11. *Stiva royana* Iredale, Type.

Plate xxxv.

1. *Neotrigonia gemma* Iredale.
2. *Solamen rex* Iredale.
3. *Glycymeris striatularis suspectus* Iredale, Type.
4. *Austrotriton parkinsonius basilicus* Iredale, Type.
5, 6. *Eligidion audax* Iredale, Type. 5. side view; 6. from above.
7-9. *Ethminolia probabilis* Iredale, Type. 7. from above; 8. from side; 9. from below.
10. *Fusus grandis* Gray, Type.
11. *Spectamen philippensis* Watson.
12. *Minolia pulcherrima emendata* Iredale, Type.
13. *Microvoluta royana* Iredale, Type.
14. *Nuculana dohrnii* (Hanley).
15. *Nuculana (dohrnii) tragulata* Iredale.
16, 17. *Triviella merces* Iredale, Type. 16. from above; 17. from below.
18, 19. *Glycymeris flammeus* Reeve. 18. hinge; 19. hinge of young.
20. *G. hedleyi* Lamy.
21. *Amygdalum beddomei* Iredale, Type.

Plate xxxvi.

1, 17. *Leiopyrga lineolaris* Gould. 1. variation; 17. normal.
2. *L. octona problematica* Iredale, Type.
3, 12, 13. *Gazameda gunnii* Reeve. 3. Disaster Bay form; 12. normal; 13. from deepwater.
4, 15. *Colpospira guilleaumei* Iredale, Type. 15. side view of mouth showing sinus.
5. *C. quadrata* Donald.
6, 7. *Terebra brazieri* Angas. 6. sculptured form; 7. smooth form.
8. *Baryspira oblonga* Sowerby.
9. *B. fusiformis gasa* Iredale. Type from off Merimbula.
10. *B. fusiformis* Petterd.
11. *Gazameda tasmanica* Reeve, adult.
14. *G. tasmanica* Reeve, young.
16. *Pervicacia assecla* Iredale, Type.

Note added 16 Sept., 1924.—I find that some years ago Cossman designated *Ancilla australis* Sowerby as the type of *Baryspira*. This should be noted in 5th line from bottom of page 259 and also line 6 on page 260.

TWO NEW THRIPS-GALLS AND THEIR INHABITANTS, FROM NEW SOUTH WALES.

By W. Docters van Leeuwen and H. H. Karny, Botanic Gardens, Buitenzorg.

(*Communicated by J. H. Maiden, F.R.S.*)

(Three Text-figures.)

[Read 25th June, 1924.]

On one of the excursions which followed the second Pan-Pacific Science Congress (Australia, 1923) one of us (the former) had an opportunity of collecting galls in an almost tropical vegetation. In the territory of the Northern Rivers, especially round Lismore, almost the whole of the old vegetation has been cut or burned down in order to make pasture land. Only a very small spot was still left untouched at the time of this visit, and they were just beginning to cut also the trees of this last small reservation.

This forest gave the same impression as a forest on dry ridges in Java: some old tall trees and a dense underbrush. A thrips-gall was collected there, on *Randia chartacea* F.v.M., which is not mentioned in the recently published valuable work on galls from the Old World by Houard *, and which, therefore, appears to be new. Another thrips-gall was found on *Smilax australis* R.Br. in the remnant of a forest near Murwillumbah. Now, a thrips-gall on *Smilax zeylanica* L. is known to us from Java, Celebes and the islands of the Salcier-group †, and on *Smilax leucophylla* Bl. from Java and Sumatra. The new gall on *Smilax australis* R.Br. is identical with the one from the Malayan Regions and the gall-former is the same.

It is a remarkable fact that the same gall, or almost the same gall, is found in places so far from each other, and it proves that a more thorough study of the galls occurring in forests in the tropical parts of Australia should be of high value from a zoogeographical point of view. In this connection it may be of

* C. Houard. Les Zoocécidies des Plantes d'Afrique, d'Asie et d'Océanie. Tome i. et ii. Paris, chez Hermann, 1922-1923.

† J. und W. Docters van Leeuwen-Reijnvaan. Einige Gallen aus Java. Vierter Beitrag. Marcellia. Tome ix., 1910, p. 191, No. 196, fig. 80.

H. Karny und J. und W. Docters van Leeuwen-Reijnvaan. Ueber die Javanischen Thysanoptero-Cecidien und deren Bewohner. Bulletin du Jardin botanique de Buitenzorg. Série ii., No. x., 1913, p. 19, fig. 10, 11.

J. und W. Docters van Leeuwen-Reijnvaan. Beschreibungen von Gallen aus Celebes und aus den Inseln südlich von Celebes. Bulletin du Jardin botanique de Buitenzorg. Série ii., No. xxi., 1916, p. 43, N: 62.

interest that one of us (W.D.v.L.) collected a psyllid-gall on *Mallotus philippinensis* Muell. Arg. on Susan Island, Clarence River, which is the same as the one occurring in Sumatra, Java and Celebes ‡, and which has not yet been recorded from Australia.

Here follow the descriptions of the galls and of the gall-formers. Mr. Cheel, of the Herbarium of the Botanic Gardens in Sydney, has been so kind as to determine the material, for which kindness we are very much indebted to him.

1. *Randia chartacea* F.v.M.

Inhabitant: *Euoplothrips bagnalli* Hood.

The borders of the leaf are folded upwards so as to form a narrow roll

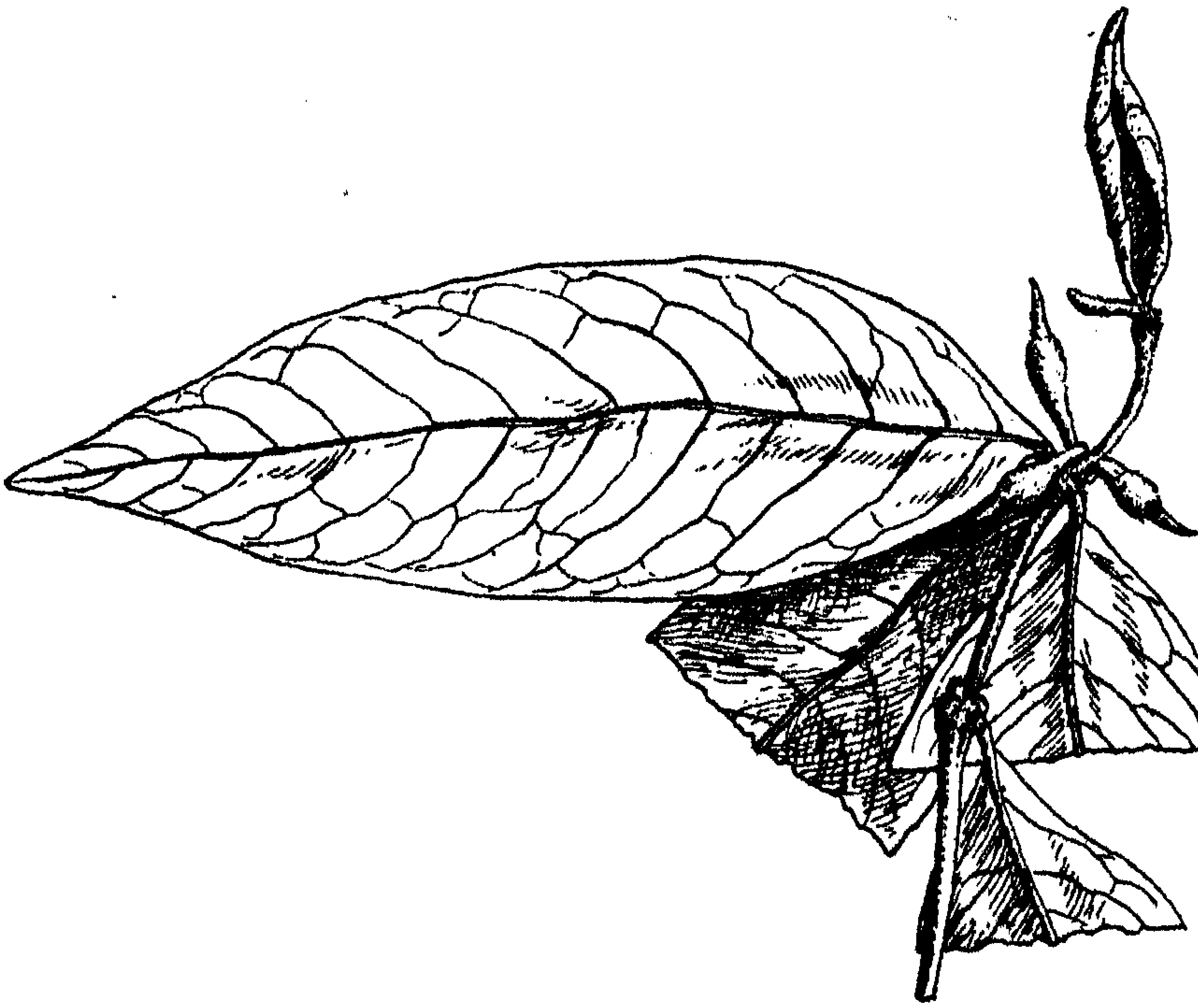


Fig. 1.—Thrips gall on *Randia chartacea* F.v.M. (Nat. size).

(figure 1). Moreover, strong and young infected leaves are totally changed into the gall, and often spirally contorted round their longitudinal axis. The surface of the gall is more or less rough and, when old, of a yellow-green colour. In this gall were found only two macromerous (♀) specimens of *Euoplothrips bagnalli* Hood. It is, therefore, impossible to state whether this species is the true gall-former or merely an inquiline, as seems to be the case in the following gall.

‡ J. und W. Docters van Leeuwen-Reijnvaan. Einige gallen aus Java. Sechster Beitrag. Bulletin du Jardin botanique de Buitenzorg, Série ii., No. iii., 1912, p. 33, N: 307.

Type gall: 20922. Lismore. Part of a virgin forest. 11 Sept., 1923. Field N: 7344.

2. *Smilax australis* R.Br.

Inhabitants: *Cryptothrips* (?) *intorquens* Karny; *Euoplothrips bagnalli* Hood.

The thrips attack those parts of the leafblade that adjoin the midrib of the leaf and the two strong longitudinal veins that traverse the leaf from the base to the apex. The infected parts curl upwards so as to form three narrow cases in which the creatures live. In case of strong infection, the whole leaf is formed into a roll (figure 2). The infected parts of the lamina are, moreover, rough,

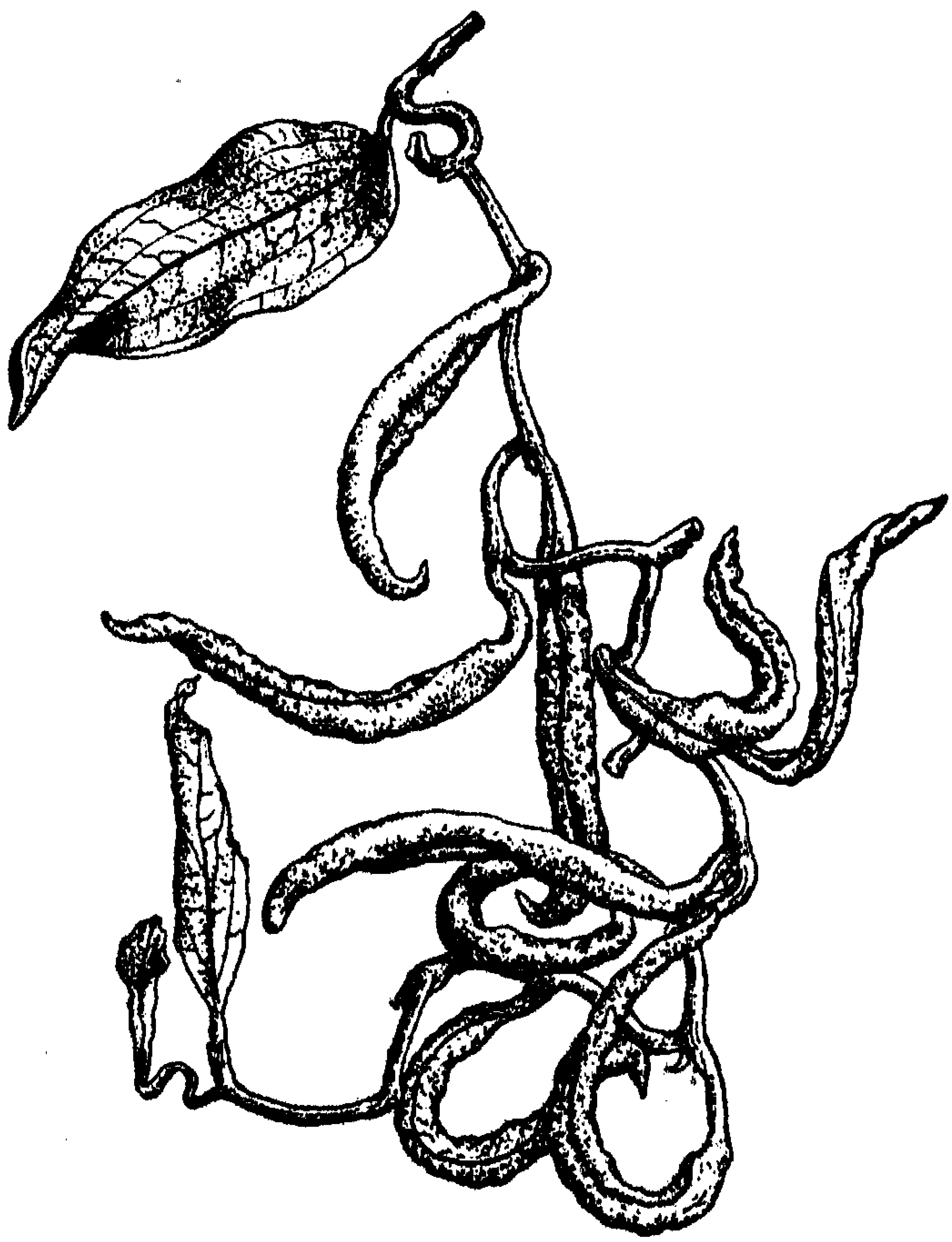


Fig. 2.—Thrips gall on *Smilax australis* R.Br. (Nat. size).

and dotted with irregular pustules. Besides, the leaf often twists itself once or twice round its longitudinal axis.

When, as sometimes happens, only one of the side-veins is affected, the other half of the leaf remains flat. The anatomy of the Javanese galls was investigated and described by us. It is a striking fact that a great number of tracheids

develop from the mesophyll-cells. These often form thick clubs or bunches in the vicinity of the larval-cavity.

In these galls were found two species of Tubuliferous Thysanoptera, both about equal in number of individuals, viz., *Cryptothrips intorquens* Karny and *Euoplothrips bagnalli* Hood. As to the former species, the Australian specimens which are in our possession agree very well with the Javanese types. Only the tooth of the fore-tarsal of the ♂ (always absent in the ♀) is less developed here, in general, than in the specimens from Java; in some of the Australian material even entirely wanting. According to this character, the species could perhaps be rather placed in the genus *Eothrips* Hood (1915), especially as the length of head is also somewhat shorter than in the true *Cryptothrips* and the fore-femora of the ♂ are scarcely larger than in the ♀. It is a matter of fact that the generic position of many Tubulifera is somewhat doubtful, and a matter of subjective decision, in consequence of the very unsatisfactory generic characters used by Uzel, such as relative length of head, armature of the fore-tarsi, etc. It is much to be hoped that more useful differences may be detected in future. Perhaps they may be found in some larval characters, the study of which has recently been inaugurated by Priesner and promises important results systematically.

Euoplothrips bagnalli was described by Hood (Mem. Q'land Mus., vi., 1918, 121-150) from one female "Taken by sweeping in a jungle at Nelson, N.Q.,

Fig. 3.—Fore-legs of a macromerous (left) and a micromerous (right) ♂ of *Euoplothrips bagnalli* Hood.

May 30th, 1912, by Mr. A. A. Girault." As this author stated, this species is, in fact, very closely related to the genus *Androthrips*. Though nothing was known as to the life-history of the type specimen, Mr. Hood supposed, from its systematic position, that it was "without doubt a gall-making genus." It is, however, not yet certain whether it is a true gall-former. At all events Mr. Hood was really right in expecting it to be a gall-inhabitant.

From the material in our possession we can complete Hood's description by the following additions: the 6th antennal segment is in some specimens paler at base as described by Hood, being in others entirely dark. The number of accessory fringe hairs on fore-wings is, in our material 12-18, being in Hood's type specimen "about ten." The ♂ (hitherto unknown) differs from the ♀ by no means except the genitalia. As to the shape of the fore-legs, there is a considerable variation (fig. 3) in the ♂, some being macromerous, others micromerous, as in *Thaumatothrips froggatti* Karny, described some time ago (These Proc., xlii., 1922, 266-274). The micromerous ♂ has also the armature of the fore-legs less developed than the macromerous specimens, as may be seen from the figures. All the females in our possession are macromerous.

Type gall: 20921. Murwillumbah. Remnant of a forest. Shrubbery. 12 Sept., 1923. Field N: 7369.

ON SOME AUSTRALIAN SCARABAEIDAE (COLEOPTERA).

By Arthur M. Lea, F.E.S.

(Nineteen Text-figures.)

[Read 30th July, 1924.]

When Masters' Catalogue of Australian Coleoptera was compiled, slightly more than 600 species of Scarabaeidae were recorded; at the present time nearly 2,000 are known; and these include many of our showiest beetles and others of great economic importance. It is probable, however, that our Melolonthides alone exceed 2,000 in number, as hundreds of unnamed species of the immense genus *Heteronyx* alone are known to me, and of many other genera of small species many remain to be named. The Rutelides and Cetonides are better known than the other subfamilies, but even to these many species have still to be added.

COPRIDES.

Onthophagus quadrinodicollis, n.sp.

♂. Black, shining; antennae, palpi, and tarsi reddish, club paler. Under surface and legs with rusty-red hairs; the wide lateral interstice of elytra, and pygidium with rather short setae.

Head wide, sides strongly dilated in front of eyes, a flat space between eyes quadrilobed in front, the two median lobes smaller than the others and feebly upturned; space between lobes and clypeal suture with very feeble, but not very small, punctures, becoming subvermiculate on sides. Clypeus with outlines continuous with those before them, and almost equally elevated, but truncated and slightly higher in front, surface closely transversely vermiculate; suture rather acutely carinated, in three parts, the median part almost straight (as seen from directly above) and about three-fifths of the whole. Eyes large, facets indistinct. Prothorax slightly wider than elytra, sides strongly rounded, front angles produced but rounded, a distinct gutter near each side, sides rather strongly margined, apex moderately margined, base depressed and scarcely margined, front fifth retuse in middle, the retuse portion shining and surmounted by four obtuse tubercles, of which the median ones are rather distant; between each of these and the one nearer the side a shallow depression to apex, a rather shallow median line from near summit of retuse portion to base; with minute and rather sparse punctures in middle, becoming larger, but somewhat obsolete, towards and on sides; sublateral foveae rather large. Elytra with geminate striae, containing distant punctures; interstices separately convex, very finely shagreened, with distinct punctures only on sides. Metasternum with dense asperate punctures on

sides, becoming larger, sparser, and more sharply defined elsewhere. Apical segment of abdomen moderately narrowed in middle; pygidium with large punctures. Length, 10 mm.

Hab.—Northern Territory: Darwin (N. Davies).

The flat quadrilobed interocular space distinguishes this species from all others before me.

ONTHOPHAGUS GRANICOLLIS, n.sp.

♂. Black, opaque; under surface and legs with rather long whitish-grey hairs, almost as long on head but somewhat darker; prothorax with rather dense, rusty-brown, upright setae; elytra with shorter and darker setae, confined to two rows on each interstice.

Head with a short, erect horn near each eye, the space between these and clypeal suture with numerous granules. Clypeus wide, deeply notched, each side of apex conspicuously produced, margins conspicuously elevated; surface densely granulate-punctate, suture trisinuate, median portion feebly arched, and about three-fifths of the total. Eyes narrow, facets very distinct. Prothorax large, sides strongly rounded, front angles obtusely produced, hind ones very wide, margins conspicuous on sides, less so at apex and feeble at base; middle near apex with a small curved ridge, forming, with the two cephalic horns, the corners of an equilateral triangle; with small, dense, round, setiferous granules, absent from base of median line (which otherwise is but feebly defined), and, from parts near sublateral foveae, these rather deep. Elytra with very narrow striae, interstices moderately convex, very finely shagreened, and mostly with two rows of small, setiferous punctures. Under surface opaque and punctures not sharply defined, four apical segments of abdomen narrowed to middle. Length, 7 mm.

Hab.—Western Australia: Mount Barker (S. Macsorley).

An isolated species, at first glance somewhat resembling the female of *O. haagi*, but the head, prothorax and elytra are all very differently sculptured; the elytra are somewhat as on *O. jubatus*, but the head and prothorax are very different; *O. granulatus* has the head and elytra very different and the prothorax with much sparser granules. The antennae are black, except that the second and third joints are obscurely reddish. The elytral setae are indistinct from some directions, but abundantly distinct from the sides.

GEOTRUPIDES.

The Australian genera of this subfamily may be thus tabulated:—

Elytra with more than five striae between suture and each shoulder. *Bolboceras* (in part).

Elytra with five striae between suture and each shoulder.

- Scutellum much longer than wide .. .. *Stenaspidius.*
- Scutellum about as long as wide.
  - Middle coxae almost touching .. .. *Eucanthus.*
  - Middle coxae widely separated .. .. .. *Bolboceras*, subg. *Bolbapium.*

BOLBOCERAS TRICAVICOLLE, n.sp.

♂. Castaneous; some margining and projecting parts darker. Under surface and legs with rusty-red hair.

Head with a somewhat pyramidal mass between apex to near base, its summit with an elongate projection on each side, its front with two subconical

tubercles projecting forward. Mandibles large, notched before and at apex. Prothorax almost vertical and with three large excavations in front, the larger one separated from the summit by an obtuse ridge, the others frontal and each scarcely half the size of the large one, and shallowly connected with it; basal portion in middle about one-fourth the length of the segment, and with a median line; with a few large punctures and fairly numerous minute ones; with minute granules irregularly distributed, but becoming dense about sublateral foveae. Scutellum with sub-obsolete granules. Elytra with seven striae, containing distinct but not very large punctures, between suture and each shoulder. Front tibiae with six teeth, hind tibiae bicarinate. Length, 20 mm.

Hab.—Western Australia: Swan River (J. Clark).

Belongs to Subgroup 1, of Group 2, of Blackburn's revision of the genus, and would be there associated with *B. frontale,* which has the prothorax armed in the male, and is otherwise very different. The almost vertical front of prothorax, with three large cavities, and the curiously armed head are very different from any other species before me. On the type the projection on each side of the raised mass is about as long as the distance from its base to the front of the clypeus, the smaller frontal projections are about one-fourth more distant from each other than from the front of the clypeus.

Bolboceras corrugatum, n.sp.

Black; parts of legs obscurely diluted with red. Under surface and legs with rather dense, greyish hair.

Head with frontal elevation in the form of a narrow curved ridge, extending half-way between the eyes, outer corner of each frontal wing slightly elevated; clypeus small, its middle subconical, behind it a transverse space divided into two irregularly four-sided areolets by carinae, the hind outer corner of each areolet elevated; with irregularly distributed punctures of various sizes. Prothorax large, evenly convex, sides strongly rounded and widest near base, base strongly rounded in middle; with fairly numerous, large, irregularly distributed punctures, and some small ones; sublateral foveae represented by clusters of punctures. Scutellum triangular, distinctly longer than wide, and with large and rather dense punctures. Elytra with large approximate punctures in wide striae, of which there are seven between suture and each shoulder; interstices, except at base and on apical slope, narrower than striae. Front tibiae with ten teeth, middle coxae widely separated. Length, 8 mm.

Hab.—Queensland: Cairns district (F. P. Dodd).

At first glance somewhat like *Stenaspidius nigricornis,* but with seven striae between suture and each shoulder. The scutellum is decidedly longer than is usual in *Bolboceras;* possibly a new genus may be considered necessary for it, but failing this it could, by Boucomont's table (Ann. Soc. Ent. Fr., 1910, p. 337), only be referred to *Bolboceras.* The first elytral stria is narrowed and deflected by the scutellum, but it attains the base. Regarding the species as belonging to Group 3, of Blackburn's revision, it is distinct from all of them by the wide and deep elytral striae, with comparatively narrow interstices, and by the rather long scutellum; to the naked eye the elytra appear finely corrugated. A second specimen, from Cairns (H. Hacker), differs from the type in being smaller (6 mm.), the sides, suture and shoulders of elytra, and sides of prothorax obscurely reddish, and the legs paler; its prothorax has no small punctures, and

much sparser large ones (about thirty altogether, excluding the submarginal ones) and its front tibiae have but six teeth.

Var. FLAVOCASTANEUM, n. var. Three specimens from southern Queensland (Buderim Mountain, Mapleton and Brisbane, H. Hacker) are flavo-castaneous, with basal two-thirds of head and most of under surface black or blackish, and the scutellum infuscated; the antennae, palpi and legs (except some projecting parts of the latter) are also decidedly pale; the prothoracic punctures are as on the type, the teeth of the front tibiae vary in number from six to nine (on one specimen there are eight on one, and nine on the other).

EUCANTHUS TRICARINATICEPS, n.sp.

Dark castaneous; some marginal and projecting parts darker, antennae, palpi and parts of legs paler. Under surface and legs with rusty-red hair.

Head with irregularly distributed and rather large punctures, fairly numerous, but not dense, at base, becoming crowded in front; with three transverse carinae: one connecting the eyes, one connecting the front edges of the ocular canthi, and one at base of clypeus. Prothorax about twice as wide as the median length, front angles acute, hind ones rounded off; with large punctures, mostly confined to the depressed parts, and with minute ones more evenly distributed. Scutellum about as long as wide, with sparse and small punctures. Elytra with large punctures in deep striae, of which there are five between suture and each shoulder; interstices with minute punctures, separately convex, the even ones wider than the others, the second and the sixth (at shoulders) widest of all. Front tibiae with four teeth; middle coxae slightly separated. Length, 7-9 mm.

Hab.—South Australia: Ooldea, Barton (A. M. Lea); Western Australia: Geraldton (J. Clark).

The scutellum is much shorter than in *Stenaspidius*, and the middle coxae are almost touching, so it seems desirable to refer this species to *Eucanthus*; from the description of *E. felschei* it differs in having the head tricarinated, prothorax with coarse punctures, and scutellum with sparse ones. At first glance it appears to belong to Blackburn's Group 3, of *Bolboceras*, but the elytra have only five striae between the suture and each shoulder, and the cephalic structure is different. The prothorax has an obtuse ridge, scarcely a carina, across the median fourth at the apical third, and around it numerous large punctures, between it and the base there is a conspicuous median line containing two rows (conjoined at the base) of punctures, towards each side there are two irregular transverse impressions containing large punctures, and all the gutters contain large punctures.

MELOLONTHIDES.

LIPARETRUS CRIBRICEPS, n.sp.

Black, shining, some parts with a slight opalescent gloss; elytra obscurely flavous, suture, sides, base and apex more or less infuscated, four joints of antennae, tibial teeth and claws more or less reddish. Clothed with whitish hair, dense on under surface and hind parts, elytra glabrous.

Head obliquely flattened and with crowded and sharply defined punctures between eyes. Clypeus concave, with larger punctures than on rest of head, becoming larger and sparser in front, sides evenly decreasing in width to apex, which is gently incurved to middle. Antennae nine-jointed. Prothorax with front angles acutely produced, hind ones almost rounded off, median line well defined; punctures about as large as on head, with some larger ones scattered

about. Elytra each with three pairs of striae, containing fairly large punctures, elsewhere with smaller but well defined punctures, a few oblique strigosities towards sides. Pygidium and propygidium with punctures of two sizes as on prothorax. Front tibiae with three teeth, the second acute and nearer the third (which is very feeble) than the first; basal joint of hind tarsi slightly shorter than second. Length, 8.5-9 mm.

Hab.—Western Australia: Kellerberrin.

Belongs to Group 2; as the clypeus, however, is somewhat incurved at the apex it is distinct from all the species referred to that Group by Blackburn; regarding the two basal joints of the hind tarsi as of equal length, it would be referred to Group 5, and there associated with *L. glabripennis*, from the description of which it differs in being considerably larger, and in the clypeus not rounded in front. To a certain extent it resembles *L. luridipennis* (of Group 12) on an enlarged scale. The hair on the prothorax is fairly dense on the apical third, and fringes the base and sides, the intervening part (as viewed from the sides) being glabrous; the upper surface of the head on the two specimens examined is almost glabrous, but may have been abraded. The clypeus is slightly more upturned in front (and consequently more largely concave) on one than on the other, but they are probably both males.

LIPARETRUS TARSALIS, n.sp.

♂. Black, somewhat shining; antennae (club infuscated), palpi, front tibiae and tarsi, and middle tarsi more or less reddish. Under surface with rather dense, greyish-white hair, becoming sparser on hind parts.

Head with crowded and rather small but sharply defined punctures, an obtuse elevation on each side of middle, with a gentle depression to clypeal suture. Clypeus with somewhat larger, less crowded, and better defined punctures, suture gently arched forward, sides strongly diminishing to near apex, with the front angles oblique and very acute, front evenly and rather strongly incurved. Antennae nine-jointed. Prothorax with surface somewhat uneven, front angles acute, hind ones rounded off, median line scarcely traceable; punctures dense but not crowded, somewhat as on clypeus, but less regular. Elytra with fairly large and dense punctures, and some slightly larger ones in geminate striae. Hind parts with punctures slightly smaller and denser than on elytra. Front tibiae strongly tridentate; front tarsi with a longitudinal impression on the outer side of each joint, basal joint acutely ridged on its lower edge; front claws rather stout, and with an obtuse basal process; basal joint of hind tarsi slightly shorter than second. Length, 10 mm.

Hab.—New South Wales: Grenfell (Dr. E. W. Ferguson).

There are some long hairs on the apex of prothorax, and the sides and base are distinctly fringed; there appear also to be stumps of hairs near the apex, so the type has probably been partly abraded; if non-abraded, it belongs to Group 4, in which it certainly seems out of place; if abraded, it might be associated with *L. kreuslerae*, from which it differs in the acutely angled clypeus and ridged basal joint of front tarsi; its tarsi associate it with *L. ater* and *L. phoenicopterus*; from the description of the former it should be distinct by its head and size, from the latter it differs in its colour of elytra and in the clypeus; from *L. niger* and *L. insignis*, it is distinct by the clypeus more strongly narrowed, with the front angles more acutely projecting, and by the feeble tubercles of head. In Macleay's grouping it would belong to Subsection 1 of Section 1, and

it is the first large black species with acutely angular clypeus to be recorded from New South Wales.

LIPARETRUS BILOBUS, n.sp.

Flavous; head, prothorax and parts of legs somewhat darker than other parts. Under surface and hind parts with short clothing, upper surface glabrous, except for marginal fringes, and a few submarginal hairs on elytra.

Head moderately convex, with small and ill-defined punctures. Clypeus rather short and concave, with somewhat larger punctures than on rest of head, front distinctly bilobed, suture gently bisinuate. Antennae nine-jointed. Prothorax strongly convex, with a wide apical membrane, front angles acutely produced, hind ones almost rounded off, median line absent; punctures fairly dense, but small and ill-defined. Elytra each with four slightly convex ridges bounded by geminate rows of small punctures, the interstices wide and also with small punctures. Hind parts with rather dense and small punctures. Front tibiae obtusely tridentate; hind tarsi with basal joint slightly shorter than second. Length, 7.5 mm.

Hab.—Northern Territory: Daly River (H. Wesselman).

The first and second joints of the hind tarsi are almost equal, the first being a trifle the shorter; regarding it as such it would belong to Blackburn's Group 4, and there associated with *L. aridus,* which in general it strikingly resembles, but from which it is at once distinguished by the bilobed clypeus; it also closely resembles *L. flavus* (of Group 14), but the clypeus and front tibiae are different. If referred to Group 7 it would be associated with species with which it has few details in common.

LIPARETRUS LONGIPILIS, n.sp.

Black, in parts with a faint opalescent gloss; parts of elytra obscurely diluted with red, antennae (except club), palpi, and tarsi reddish. Under surface and legs with rather dense, whitish hair, becoming sparser, but still fairly dense, on hind parts; prothorax and head (except clypeus) with fairly dense, erect, black or blackish hair.

Head obliquely flattened and with densely crowded punctures. Clypeus rather short, moderately concave; with slightly larger and less crowded punctures than on rest of head, front angles strongly rounded off. Antennae nine-jointed. Prothorax with a fairly long apical membrane, front angles acutely produced, hind ones rounded off, median line feeble; punctures fairly dense and of several sizes. Elytra with geminate rows of fairly large punctures, those on the interstices almost as large, but not as close together; each side with a partial fringe of setiferous granules, the setae short and stiff. Hind parts with punctures much as on clypeus. Front tibiae acutely tridentate. Length, 7 mm.

Hab.—Western Australia: Busselton (Edgar R. Waite).

From some directions the first joint of the hind tarsi appears to be slightly shorter than the second, but when examined so that its extreme base is visible, it appears to be the length of the second, or even a trifle longer; it is certainly not "distinctly longer" (as in Group 8), hence it might be referred to either Group 2 or 5. If to Group 2, it would be associated with *L. dispar,* which is a much larger species, with coarser prothoracic punctures and less of elytra dark; if to Group 5, it would go with *L. erythropterus* and *L. amabilis;* from the description of the former it differs in its darker and pilose hind parts, and

from that of the latter in being larger, and hind half of body darker. The entirely black club and simple clothing of hind parts distinguish it from the darker specimens of *L. vestitus* and *L. nigroumbratus*; it has the general appearance of some of the darker specimens referred by Blackburn to *L. vestitus*; it also resembles some of the darker specimens of *L. picipennis*, and of *L. incertus* (of Group 4).

LIPARETRUS ORTHODOXUS, n.sp.

Black; elytra (base infuscated), hind parts (base of propygidium infuscated), and most of legs red or reddish, antennae and palpi flavous. Under surface moderately clothed with whitish hair, becoming sparser on abdomen and absent from hind parts, prothorax with erect discal hairs and apical and lateral fringes, elytra glabrous.

Head with crowded and rather coarse punctures, the interspaces with minute ones. Clypeus rather short, slightly concave, suture distinctly bisinuate, sides oblique to apex, which is truncated, with the angles but slightly rounded off. Antennae nine-jointed. Prothorax with front angles acutely produced, hind ones rounded off, median line conspicuous near base, but scarcely traceable elsewhere; with large scattered punctures and fairly numerous smaller ones. Elytra rather short, with fairly large punctures in geminate series, the interstices with almost equally large ones. Hind parts with fairly large, dense punctures, on the pygidium mixed with some larger ones. Front tibiae tridentate, the third tooth rather obtuse; basal joint of hind tarsi conspicuously longer than second. Length, 8 mm.

Hab.—Queensland: Bowen (Aug. Simson).

In Blackburn's table would be referred to FF, of Group 8, from all the previously described species of which it is distinguished by the clypeus not being tridentate. It is quite an ordinary-looking species, resembling more or less closely bicoloured specimens of other groups, from which it is at once distinguished by the long basal joint of the hind tarsi. The upper surface of the head of the type is glabrous, but may have been abraded; the geminate rows of punctures on the elytra are sharply defined, but are contained in very feeble striae.

LIPARETRUS PILICEPS, n.sp.

Black, subopaque; elytra of a dingy flavous-brown; base, suture, sides, and apex more or less infuscated, antennae, palpi, and most of legs reddish or flavous. Sterna with moderately dense, whitish hair, sparser on abdomen, still sparser and shorter on hind parts, head with flavous hairs between eyes, prothorax with side fringes only, elytra glabrous.

Head with crowded and rather small punctures, with some larger ones (each containing a hair) scattered about. Clypeus moderately concave, sides rather strongly narrowed from base to apex, apex slightly incurved to middle, suture strongly bisinuate; punctures slightly larger and less crowded than on rest of head. Antennae nine-jointed. Prothorax with front angles subacutely produced, hind ones completely rounded off, median line distinct near base and traceable almost to apex; punctures rather small and numerous, but not crowded. Elytra short, with distinct geminate striae containing fairly large punctures, interstices with somewhat similar, but more distant, punctures. Hind parts with punctures much as on clypeus. Front tibiae acutely tridentate; hind tarsi with first joint distinctly longer than second. Length, 5.5 mm.

Hab.—South Australia: Murray River (F. R. Zietz).

A rather small, dingy species, in general appearance fairly close to *L. bituberculatus*, but apex of clypeus gently curved instead of tridentate; in Blackburn's table of its Group (10), it would be associated with *L. convexior* and *L. laeticulus*; the latter is a much smaller species with sharply defined punctures on prothorax and elytra, etc.; from the description of the former (which is hardly more than a comparison with *L. rotundipennis*), it differs in having the prothorax opaque, and elytra of two colours; *L. rotundipennis* has the clypeus rounded in front and, with *L. convexior*, was placed in Macleay's Subsection 3, having the "Clypeus more or less rounded in both sexes; it also resembles some of the moderately dark specimens of *L. rubefactus* (Group 4). Parts of the under surface and legs have a slight pruinose gloss."

Liparetrus cribripennis, n.sp.

Black, shining; prothorax subopaque, antennae (parts of club infuscated) and palpi reddish. Sterna and parts of abdomen with fairly dense, whitish hair; upper surface glabrous.

Head moderately convex, with rather small and numerous, but not dense, punctures. Clypeus almost semi-circular, sides almost evenly elevated, suture fairly deep; punctures sparse and minute. Antennae nine-jointed. Prothorax with apical membrane rather wide, front angles moderately produced, hind ones completely rounded off, median line absent; with fairly large and dense, but shallow, obsolete punctures. Elytra short, sides and tips strongly rounded; with large and fairly dense punctures, the geminate rows very ill-defined. Hind parts with dense, sharply defined punctures, obtusely ridged along middle. Front tibiae unidentate, apical process long and acute, basal joint of hind tarsi longer than second. Length, 8 mm.

Hab.—South Australia: Ooldea (A. M. Lea).

In Blackburn's table belongs to EE, of Group 13, and from all the species there noted it differs in the black elytra; *L. caviceps* and *L. rotundipennis* have the front tibiae bidentate, and differ in other details; there are many black species of other Groups, but the characters noted in the table are ample to distinguish the present from all of them. The base of the clypeus, as seen from behind, appears to be traversed by a conspicuous ridge, with distinct punctures (the only distinct ones on the clypeus) on its posterior end; from directly above, it appears to slope evenly downwards to the base of the elevated margin. On the type, the base of the propygidium is exposed, has a bluish-white gloss, and is densely clothed with white pubescence, but it would probably be concealed on most specimens.

Liparetrus geminatus, n.sp.

Castaneo-flavous; head (including clypeus, or not), sterna, and base of abdomen black, club infuscated. Sterna with moderately dense white hair, abdomen more sparingly clothed, hind parts and upper surface glabrous.

Head with dense and sharply defined punctures, but base impunctate; a vague depression in middle at clypeal suture. Clypeus with sides feebly elevated and oblique to apex, which is evenly rounded, two distinct sub-conjoined elevations in middle of base, suture deep and bisinuate; punctures slightly sparser and larger than between eyes. Antennae nine-jointed. Prothorax very short, front angles almost rectangular, hind ones rounded off; punctures rather shallow and ill defined, but not very small. Elytra with geminate rows of punctures of

moderate size, the interstices with somewhat smaller ones. Hind parts with crowded punctures of moderate size, and with an obtuse interrupted ridge. Front tibiae unidentate, apical process long and very acute, hind tarsi with basal joint distinctly longer than second. Length, 4.5-5 mm.

Hab.—South Australia: Barton (A. M. Lea).

A small species, very distinct from all others known to me by the two projections at base of clypeus; of seven specimens obtained, three have the clypeus as pale as the prothorax; on the others it is black. In Blackburn's table of Group 13, it would be associated with *L. modestus*, from the type of which it differs in the deep black head, with clypeal projections, and in the even sweep of the front tibiae (on the type of *L. modestus* there is a feeble projection near the outer base of the left front tibia—the right one is missing); *L. minor*, which is about the same size, has the hind parts darker, and is without clypeal projections.

Liparetrus tibialis, n.sp.

Castaneo-flavous; elytra flavous, head and sterna black or blackish, club and scutellum infuscated. Sterna moderately clothed with white hair, becoming sparser on abdomen; hind parts with white pubescence, except on tip of pygidium, where there are a few hairs, head with a few short erect hairs, sides of prothorax with long fringes, rest of upper surface glabrous.

Head with crowded and somewhat coarse punctures, slightly larger on clypeus than elsewhere. Clypeus almost semi-circular, margins moderately elevated, suture deep. Antennae eight-jointed. Prothorax with front angles moderately produced, hind ones rounded off, median line very distinct at base and traceable throughout; punctures about as large as on head, but less crowded. Elytra with moderately large and dense punctures, geminate rows ill defined. Hind parts with dense, but partially concealed, punctures. Front tibiae unidentate, apical process long and acute; basal joint of hind tibiae decidedly longer than second. Length, 4-4.25 mm.

Hab.—South Australia: Ooldea (A. M. Lea).

Of the two species referred by Blackburn to Group 18 (to which this species belongs) it differs from *L. laevatus* (from Queensland) in having the clypeus evenly rounded in front, and the hind parts pale and moderately clothed; and from the description of *L. laetus* in its much smaller size, and by the front tibiae; these at first appear to be unidentate, but the even sweep of the outer edge is feebly interrupted near the middle on two specimens, although the interruption is certainly not a distinct tooth, and from one specimen it is altogether absent. If Blackburn's surmise that *L. gagaticeps* (from King's Sound) belonged to Group 18, is correct, that species should be distinct from the present one by very different punctures on the head and prothorax. The antennae were examined under the microscope to make sure that they were but eight-jointed.

Liparetrus clypealis, n.sp.

Castaneous; elytra (which are shining) paler than prothorax (which is opaque), head, edges of prothorax, scutellum, and sterna black, antennae flavous, parts of club infuscated. Sterna with moderately dense white hair, becoming sparser, shorter, and mostly depressed on abdomen (including the hind parts).

Head with dense and sharply defined, but rather small, punctures, a feeble transverse median elevation in middle. Clypeus with sides strongly narrowed to

apex, front moderately elevated, truncated across middle, but with angles strongly rounded, suture distinct towards sides, but interrupted in middle; punctures somewhat larger and less crowded than on the rest of head. Antennae seven-jointed. Prothorax with several vague transverse impressions, front angles acutely produced, hind ones very obtuse, median line feeble near base, and scarcely traceable elsewhere; punctures rather small and fairly dense, but not crowded. Elytra with geminate rows of fairly large and mostly transverse punctures; interstices with punctures of about the same size, but not transverse. Hind parts shagreened and with dense punctures, about as large as on clypeus, but less sharply defined. Front tibiae strongly tridentate, basal joint of hind tarsi conspicuously longer than second. Length, 8-8.5 mm.

Hab.—Western Australia: Mullewa (Miss J. F. May), Kellerberrin, Northam.

The antennae with but seven joints, and prothorax entirely glabrous, except for lateral fringes, can only associate this species in Blackburn's table with *L. opacicollis*, from the description of which it differs in having but one small tuberosity in the middle of the clypeal suture, an obtuse swelling on the forehead, head with rather coarse punctures, thorax only partly infuscated, and hind parts not black; the colour differences, however, are probably immaterial; structurally it is fairly close to *L. laevis* (a variable species in colour), but the prothorax is not fringed across the apex. A second specimen is coloured as the type; on a third, the apical third of the prothorax, the shoulders, and base of elytra are blackish; on a fourth, the prothorax is black, except for an obscurely reddish transverse space near the base, but the elytra are blackish only at the extreme base. The clothing of the hind parts appears to be easily abraded, but is almost perfect on two of the specimens; on most of the abdominal segments there is a transverse row of long yellowish hairs, but they are easily lost. The clypeal suture is not very deeply impressed, but is very distinct by a narrow, polished, impunctate space on each side behind it; the interruption in its middle, on three specimens, appears as a short longitudinal ridge.

MAECHIDIUS PUNCTICOLLIS, n.sp.

Black or blackish-brown, and shining; legs and parts of under surface obscurely reddish, antennae and palpi paler.

Head with coarse punctures, many semi-double; front with a deep and almost U-shaped notch, sides obliquely and almost evenly increasing in width to base, where they are suddenly narrowed to touch the eyes at about their middle. Club three-jointed. Prothorax with front angles acutely produced, sides obtusely crenulated, regularly increasing in width to near base, and then strongly incurved (or notched) to base; with rather large, round punctures, each containing a flattened granule, but no setae, becoming crowded and irregular near sides; base with a fringe of short setae. Elytra slightly dilated to beyond the middle, striae very narrow, interstices wide, each with an inner and an outer row of shallow punctures with elliptic outlines, and each with a thin depressed pale seta. Front tibiae with three teeth, the second tooth much nearer the first than the third; each claw with a basal quill. Length, 9-10 mm.

Hab.—Queensland: Coen River (W. D. Dodd).

In Blackburn's table would be associated with *M. excisicollis*, from which it differs in being shining, in the very different sculpture of elytra, and absence of setae from the discal punctures of prothorax; the sides of the head are some-

what as on *M. sordidus*, but the prothorax is notched at the sides, and with sharply defined punctures, each with a granule which does not rise above the general level.

MAECHIDIUS EUTERMIPHILUS, n.sp.

Dark reddish-brown or piceous-brown, some parts almost black; antennae and palpi paler. Upper surface with short, pale setae on the elytra in regular rows, except on the sides, where there are some long ones.

Head with rough, crowded punctures; in front with a large semi-double excavation; front widely and rather deeply emarginate, with a triangular projection on each side of the emargination, sides then slightly increasing in width to middle, and then triangularly dilated. Prothorax not twice as wide as long, rather strongly convex, sides strongly and almost evenly rounded and strongly crenulated, considerably wider at base than at apex; with large punctures, nearly all of which have a shining granule on the anterior edge. Elytra with rows of long punctures, many of which are separated by transverse shining granules. Front tibiae with two obtuse conjoined teeth in front, and a larger sub-obtuse one in middle; claws without basal quills. Length, 7-8 mm.

Hab.—Queensland: Townsville, from nests of *Eutermes* sp. (G. F. Hill).

In Blackburn's table would be associated with *M. major* and *M. gibbicollis;* from the former it differs in being much smaller, prothorax more convex, with its sides conspicuously crenulated and more rounded; from the description of the latter in the front tibiae and sides of head; *M. tibialis*, also from nests of white ants, has the head and prothorax very differently sculptured, and abnormal hind tibiae. On one specimen, the space between the lateral notch and the apex on each side of the head is evenly oblique, but on three others there is a feeble rounded projection on each side there. The outlines of the head are very different from all those given in the Transactions of the Royal Society of South Australia for 1917 (Pl. xxxvii., figs. 88-107). From some directions the prothorax appears to be covered with large, flattened granules.

DIPHUCEPHALA PARVICEPS, n.sp.

♂. Metallic coppery-green, elytra reddish, with a greenish gloss; antennae (club infuscated), palpi, and legs (knees greenish, parts of tarsi purplish) reddish. Moderately densely clothed with depressed, whitish pubescence.

Head with crowded, round, and rather shallow punctures. Clypeus with front angles elevated and filled with hair, the notch widely U-shaped. Prothorax with median line conspicuous throughout, but not very wide, each transverse sulcus rather deep, not traceable to middle, the side adjacent to it angularly dilated; punctures much as on head, but sparser adjacent to the median line. Scutellum highly polished and impunctate. Elytra with dense, asperate punctures, rather large, but not sharply defined, several interstices feebly elevated. Pygidium with dense and rather small punctures, an almost impunctate median line, the tip with a coppery gloss. Front tibiae bidentate, three basal joints of front tarsi much wider than long, and densely padded on under surface. Length, 8-8.5 mm.

Hab.—Queensland: National Park in December (H. Hacker and R. Illidge).

The median line of the pronotum is neither narrow nor shallow, being much as on the species identified by Blackburn as *D. ignota*, which, however, he referred to A.B, in his table of the genus; from that species it differs in having the head smaller, clothing slightly longer and paler, hind tarsi darker, and elytra reddish;

the head is smaller than in *D. richmondia,* and is without the deep sub-basal depression of that species; the head is also smaller than in *D. nitidicollis,* and the median line of the prothorax is narrower. The elytra, from some directions, appear to be densely and finely granulate-punctate or rather coarsely shagreened, so that the seriate punctures are not sharply defined. Of eight specimens under examination, seven have the elytra distinctly reddish (as they occasionally are in *D. richmondia*), but on the eighth they appear at most to be obscurely diluted with red.

DIPHUCEPHALA CRIBRIPENNIS, n.sp.

♂. Bright metallic coppery-green; antennae (club blackish), palpi, and legs (knees slightly greenish, most of tarsi infuscated) reddish. Moderately densely clothed with pubescence, stramineous on upper surface, white on lower surface.

Head with crowded punctures. Clypeus with front angles strongly produced and filled with hair. Prothorax with median line shallow and rather feeble in front, almost disappearing posteriorly, transverse groove on each side fairly deep, not traceable to middle, side near each subangularly dilated; punctures large, shallow and mostly well defined near median line, crowded elsewhere. Scutellum with a few distinct punctures near apex. Elytra with deep and large, subquadrate punctures, close together; with several feeble longitudinal elevations. Pygidium with dense and small punctures, mostly concealed, except at apex. Front tibiae bidentate, tarsi long, second and third joint of front pair strongly transverse. Length, 5-5.5 mm.

♀. Differs in having the head smaller, with an obtuse swelling in middle, near clypeal suture, front angles of clypeus scarcely produced, abdomen larger and more convex, and legs much shorter, with no joint of front tarsi transverse.

Hab.—Queensland: Crow's Nest (R. Illidge).

In Blackburn's table would be associated with *D. rufipes,* but on that species the clothing of the upper surface is considerably stouter (nearer scales than pubescence), the clypeus is less dilated in front, and the legs of the male are longer, with wider front tarsi; it is also close to *D. tarsalis,* but the median line of the prothorax almost vanishes posteriorly, instead of being deep and wide near base, the tarsi are also darker; *D. puberula* is slightly larger, with very different clothing; *D. nitens* is highly polished; all the other red-legged species are considerably larger.

DIPHUCEPHALA MACROPS, n.sp.

Purple; median line of prothorax, scutellum, pygidium, parts of under surface, hind femora, and most of middle ones green or coppery-green; elytra, antennae (except club), palpi (except apical joint), and most of legs reddish, parts of tarsi somewhat purplish. Upper surface with rather sparse hairs or long pubescence, becoming longer on sides, clothing of under surface shorter and paler.

Head rather small, with large irregular punctures. Clypeus almost thrice as wide as long, sides evenly rounded, front almost truncated; punctures much as on inter-ocular space. Eyes very large, extending from clypeal suture almost to prothorax, less than half on upper surface. Antennae eight, club three-jointed and small. Prothorax about two-thirds as long as wide, strongly convex, each side angularly dilated near a large and almost round sub-lateral fovea, from dilated part incurved to base and rounded to apex, median line deep and narrow; punctures large, irregularly distributed and rather sparse. Scutellum polished and almost impunctate. Elytra with large and irregular punctures, in places in

irregular striae. Pygidium with dense punctures. Hind femora much stouter than the others; front tibiae strongly bidentate, basal joint of front tarsi as long as three following combined, each of these longer than wide, claws each with a large, acute appendix. Length, 7 mm.

Hab.—New South Wales (W. Du Boulay).

The very large eyes and short and wide clypeus, truncated in front, are very different from all previously described species of *Diphucephala;* but as the type (judging by its front tarsi) is presumably a female, it seems undesirable to propose a new genus for it; in the allied genus, *Cunderdinia,* the antennae are nine-jointed.

NEOHETERONYX.

The monotypic species of *Neoheteronyx* (*N. lividus*) was characterised as distinct from *Heteronyx* by the mentum being strongly convex and narrower, maxillary palpi long and thin, and front and middle tarsi of the male rather strongly dilated. It was also noted as having the antennae composed of eight joints (three forming the club); labrum altogether below the clypeus; eyes large and entire, hind coxae on sides shorter than second ventral segment, front tibiae of male bidentate and of female simple, and claws appendiculate. Also "The general facies is very similar to *Heteronyx* though the head looks disproportionately large." In the table given (Trans. Roy. Soc. S. Aust., 1898, p. 34) it was distinguished from *Heteronyx* by "Anterior four tarsi of male strongly dilated," and it was stated (ib., 1908, p. 367) that "The four anterior tarsi of the male in the unique known species of this genus are most remarkable, resembling those of a *Harpalus.*" It will be seen, therefore, that the main feature relied upon for its generic distinction was a sexual one, and that this was so, is proved by the fact that when first revising *Heteronyx* (Proc. Linn. Soc. N.S. Wales, 1888, p. 1338) he [Blackburn] referred a closely allied species (*H. brevicollis*) to it, without expressed doubts as to its generic position; still later (Trans. Roy. Soc. S. Aust., 1910, p. 221) he described *H. coxalis* (which, as will be noted, I consider a synonym of *brevicollis*) as a *Heteronyx* and said "I was disposed to consider it generically distinct from *Heteronyx*, but on further consideration its peculiar characters appear to me to be only exaggerations of what is to be found in species that certainly must not be separated from *Heteronyx.*" I think that *N. lividus* should be regarded as belonging to a section of Group 2 of *Heteronyx* to which *brevicollis* and *coxalis* were referred. There are before me ten other species, with the same large eyes and curious appearance of head as in *N. lividus,* with the front tibiae uni-, bi-, or tridentate, with the front and middle tarsi strongly or moderately inflated (or at least longer than usual) and densely clothed in the male, and quite clearly leading up to Group 2. Moreover, some of the characters mentioned by Blackburn are not quite in accordance with the facts: on the type female of *N. lividus* the front tibiae are not simple, but are bidentate (see figure 2) although the teeth are evidently worn; on two other females, the second tooth is sharp and quite well defined, although rather small, the part in front of it, the first tooth, is slightly longer than the basal joint of tarsi. The eyes also are not entire, as the sides of the clypeus are produced backwards over about one-fourth of their length (see figure 3), the produced parts being so directed that if continued they would meet the front angles of the prothorax. The species of the group have a distinct resemblance, usually on a smaller scale, to those of *Ocnodus,* some species of which also have dilated tarsi; but their middle and hind claws, although not always the front ones, are

simple; their tibial teeth also vary in number. Although, as noted by Blackburn, the front tibiae of *Heteronyx* are nearly always tridentate, the third tooth is frequently very small, in some it is quite absent, and in a few they are distinctly unidentate. In *H. unidentatus*, from Groote Eylandt, in which the sexual differences of the front and middle tarsi are strongly pronounced, the front tibiae are unidentate in both sexes. Some species of *Heteronyx* have the mentum quite as convex, and the palpi as long and as thin. Unfortunately, in the same publication, and in the same year, he had previously given a *Heteronyx* the same specific name (Proc. Linn. Soc. N.S. Wales, 1889, p. 437 and p. 1255) so that on referring *N. lividus* to *Heteronyx* it becomes necessary to alter its name.

HETERONYX HARPALINUS, n. nom.

H. (*Neoheteronyx*) *lividus* Blackb., n.pr.

This new name is proposed for *Neoheteronyx lividus*, for which a change is necessary; see note (above) on *Neoheteronyx*.

HETERONYX BREVICOLLIS Blackb.

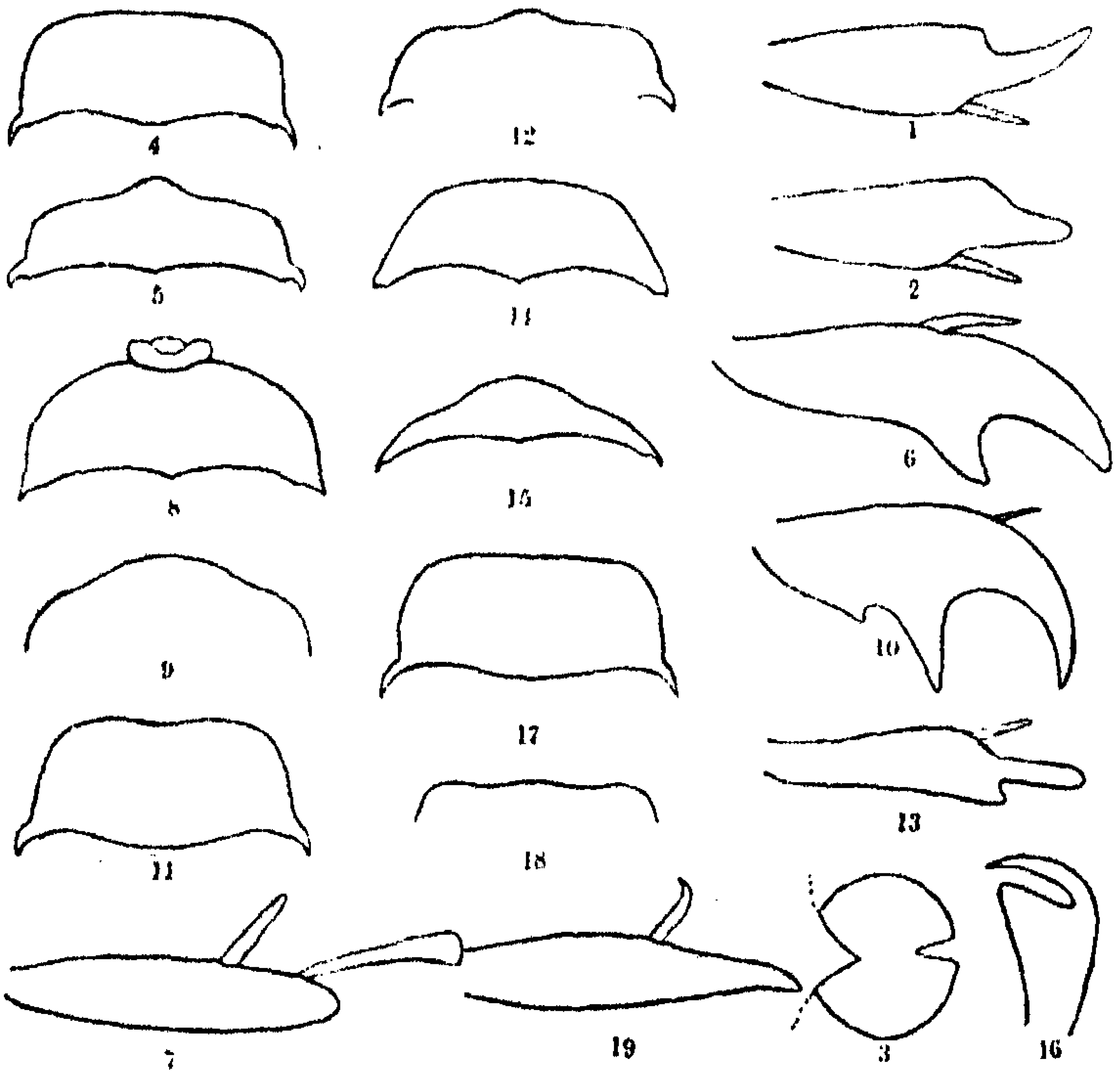
H. coxalis Blackb.

Closely allied to the preceding species, but with sides of clypeus differently curved about eyes, its median projection (viewed from behind) slightly more prominent, prothorax and elytra with somewhat coarser punctures, and elytral interstices feebly but moderately distinctly elevated. The type was from New South Wales, and other specimens from the same State agree closely with it; two specimens in the National Museum from the Howitt collection (without locality labels) differ from the type in being smaller, and with the median projection of the clypeus scarcely visible; a specimen labelled as from Tasmania (in the Macleay Museum) has the ridged appearance of the elytral interstices more conspicuous than usual; one from Bowen is slightly wider than the others, and has the elytral interstices without a ridged appearance, owing to the greater irregularity of their punctures; other Queensland specimens are from Mackay and Gayndah, the latter one was found amongst the duplicates in the Macleay Museum, but the species was certainly not described by Macleay when dealing with the Gayndah beetles.

I believe that *H. coxalis* was founded upon the same species (the type of *H. brevicollis* was in the Macleay Museum when *coxalis* was described), the strongly transverse prothorax, short hind coxae and long basal joint of hind tarsi are features common to *N. lividus* (now *H. harpalinus*) and all its close allies, and (in combination) found in no others of Group 2, or, in fact, elsewhere in the genus. In examining the type of *H. coxalis*, prior to its despatch to the British Museum, it was noted as being a small, short, coarsely punctured species, but at the time no specimen of *H. brevicollis* was available for comparison. The type of *H. brevicollis* is now before me (on loan), the basal angles of its prothorax, seen perpendicularly to themselves, are certainly slightly more than right angles, and are very feebly rounded off, but from the same point of view "*superne visis,*" as noted for *coxalis*, they appear to be "sharply right angles." In the original description they were noted as "obtuse (somewhat roundly)" but the type now (as it probably was when described) has the basal angles pressed closely against the elytra so as to be partially concealed. The type is a female; the male has the front and middle tarsi slightly longer, wider, and more densely

clothed, and the hind femora subangularly dilated and with a few setae on the middle of its under surface (somewhat as on *H. noctivagus*).

H. setifer, with which *H. coxalis* was compared on account of the long basal joint of its hind tarsi, belongs to Group 4; on the type of *H. brevicollis* the basal joint is certainly not as long and as thin as in *H. setifer,* but it is at least half as long again as the second; and in all the allied species it is decidedly longer than the second.



Text-figures 1-19. Parts of *Heteronyx.*

1. *H. harpalinus* Lea (*H. lividus* Blackb.), front tibia; 2. front tibia of type female, worn; 3. eye. 4, 5. *H. brevicollis* Blackb., clypeus from two points of view; 6. front tibia. 7. *H. cribifrons* Lea, front tibia and basal joint of tarsus. 8. *H. tridentatus* Lea, clypeus with portion of labrum and of mentum showing; 9. clypeus with suture invisible from behind; 10. front tibia. 11, 12. *H. clypealis* Lea, clypeus from two points of view; 13. front tibia. 14, 15. *H. inconstans* Lea, clypeus from two points of view; 16. hind claw. 17. *H. noctivagus* Lea, clypeus; 18. clypeus with suture invisible from behind. 19. *H. unidentatus* Lea, front tibia.

The following table deals only with *H. harpalinus*, *H. brevicollis* and other closely allied species, all having a characteristic appearance of the head and prothorax; in them the inflation of the front tarsi of the males varies from very pronounced to but little more than in the females, but, as with other sexual characters, has not been used in the table.

A. Front tibiae tridentate .. .. *tridentatus.*
AA. Front tibiae unidentate.
a. A polished strip immediately behind clypeal suture .. .. .. *unidentatus.*
aa. Without such a strip. .. .. *cribrifrons.*
AAA. Front tibiae bidentate.
B. Without a polished strip behind clypeal suture.
b. Clypeal margin strongly elevated in front. .. .. *clypealis.*
bb. Clypeal margin slightly elevated throughout. .. .. .. *phanophilus.*
BB. A polished strip immediately behind clypeal suture.
C. Scutellum with fairly numerous punctures.
c. Pale castaneous, approaching flavous. .. .. *harpalinus.*
cc. Dark castaneous or blackish. .. .. *inconstans.*
CC. Scutellum at most with sparse marginal punctures.
D. Prothoracic punctures smaller than on all others of AAA. .. .. *transversopolitus.*
DD. Prothoracic punctures of at least moderate size.
E. Front of clypeus (viewed from behind) feebly and evenly trilobed. .. .. *noctivagus.*
EE. Front (so viewed) slightly advanced in middle.
F. Median length of prothorax scarcely greater than that of sides. .. .. *brevicollis.*
FF. Median length notably greater .. .. .. *brevicoxis.*

Heteronyx cribrifrons, n.sp.

Reddish-castaneous; parts of under surface and of legs somewhat paler, antennae flavous.

Head large, with rather dense punctures of moderate size on frons, becoming denser and slightly larger on clypeus; clypeus with margins gently rounded and feebly upturned. Antennae eight-jointed. Prothorax about thrice as wide as the median length, front angles moderately produced, the hind ones slightly more than right angles, and not rounded off; punctures intermediate in density and size between those of frons and clypeus. Scutellum impunctate. Elytra with rather closely placed and mostly uneven rows of large punctures (about twenty rows on each elytron), the interspaces with a few minute punctures. Metasternum with crowded and coarse punctures on sides, almost impunctate in middle, sides more than twice the length of sides of hind coxae. Pygidium with coarse, crowded punctures. Front tibiae unidentate, basal joint of front tarsi thin, and about as long as three following combined, basal joint of hind tarsi almost as long as two following combined. Length, 7.25 mm.

Hab.—Queensland: Bowen (Aug. Simson).

Belongs to Blackburn's Group 2, and to the section represented by *H. brevicollis;* of the other closely allied species only *H. unidentatus* has unidentate front tibiae, and from that species it is distinct by its larger size, more parallel outlines, much denser punctures on pronotum and frons, larger elytral punctures, etc. The upper surface of the type (except for the lateral fringes) is now quite glabrous, and was probably never distinctly clothed, the pygidium has numerous hairs. The frons, immediately behind the clypeal suture, is without a shining impunctate strip, as on many of the closely allied species; the clypeus, from no direction appears to have a frontal elevation; the elytral punctures are decidedly large, so that the rows, of which there are about twenty on each elytron, are rather close together, but on the apical slope they are smaller, sparser, and irregular; the under surface of the front femora is finely serrated near the base;

the front tibiae are possibly somewhat worn, but they are now certainly unidentate.

HETERONYX TRIDENTATUS, n.sp.

Pale reddish-castaneous; elytra, abdomen, antennae, and parts of legs still paler.

Head rather large, frons and clypeus not on separate planes; frons with fairly large punctures near the base, becoming crowded at clypeal suture; clypeus itself with densely crowded punctures, its margin gently elevated, the middle lightly incurved. Antennae eight-jointed. Prothorax about thrice as wide as the median length, front angles moderately produced, hind ones rounded and obtuse (from above appearing sharply rectangular), punctures fairly large and numerous, although not dense, becoming smaller and sparser on sides. Scutellum densely punctate. Elytra with rather large and asperate (or squamose) punctures towards base, becoming smaller and sparser, but still fairly large posteriorly, sub-sutural and lateral striae distinct, the others feeble or absent. Metasternum with dense and moderately large punctures, becoming sparser and smaller in middle, sides about twice as long as sides of hind coxae. Pygidium with punctures much as on hind coxae, becoming smaller about apex; with a rather large shallow depression on each side of base, middle ridged posteriorly. Front tibiae strongly tridentate, hind tooth rather small but acute, the others long and sharp, the apical rather short and thin; front tarsi long and thin, especially the claw joint, claws each with a large basal appendix. Length, 7 mm.

Hab.—Central Australia: Macdonnell Ranges (Capt. S. A. White).

In Blackburn's table of Group 2 would be placed with *H. torvus* and *H. hispidulus*, to neither of which is it at all close, being allied to *H. brevicollis*, despite its tridentate front tibiae. The pubescence of the upper surface is very short, sparse and inconspicuous, but even so is more distinct than on others of the close allies of *H. brevicollis*, the fringes are rather feeble; the metasternum has some long pale hairs in front, the pygidium, except for the marginal fringe, is glabrous. The front of the clypeus, from a right angle, is seen to be slightly incurved, from behind the middle appears to be obtusely projecting; its front face is densely punctate, as is also the labrum; the mentum is strongly convex, but its front face is conspicuously concave. The apical membrane of the prothorax is extremely short behind the eyes and scarcely visible elsewhere, the one at the apex of the elytra is well defined, although rather short. The hind tarsi are missing but are probably similar to the middle ones, in which the basal joint is decidedly longer than the second.

HETERONYX CLYPEALIS, n.sp.

Reddish-castaneous; antennae and parts of under surface and of legs paler.

Head large, with fairly large and dense punctures, becoming crowded on clypeus; clypeus rather long, front truncated and strongly upturned, sides moderately upturned and deflected at eyes. Antennae eight-jointed. Prothorax about twice and one half as wide as the median length, sides sub-angularly dilated in middle, front angles acutely produced, hind ones not at all rounded off and slightly more than right angles (from above appearing sharply rectangular), base and apex bisinuate; with large and dense, but not crowded, punctures. Scutellum with a few punctures. Elytra with large punctures, mostly in irregular series (about twenty on each elytron), but somewhat smaller and crowded about suture and apex. Metasternum with dense and large punctures, becoming sparse

in middle, sides fully thrice the length of sides of hind coxae. Pygidium with coarse crowded punctures. Front tibiae bidentate, front tarsi dilated and rather densely padded on under surface; hind femora subangularly dilated in middle of under surface, basal joint of hind tarsi almost twice the length of second claws, appendiculate. Length, 7 mm.

Hab.—Tasmania. Type in Macleay Museum.

Belongs to Blackburn's Group 2, and has the large globular eyes, short hind coxae and long basal joint of hind tarsi of *H. brevicollis* and its close allies; the clypeus is more strongly upturned in front than on the closely allied species; from the usual point of view it appears to have the apex truncated; changing the point of view to a more forward one it appears feebly incurved to the middle and in consequence feebly bilobed (fig. 11); passing backwards, the view alters, so that the middle appears slightly projecting (fig. 12), somewhat as on *brevicollis*, or with the apex trilobed; on the present species the second tooth of the front tibia, seen at right angles, appears to be due mostly to the sudden notching of the tibia near the apex; on *H. brevicollis* it appears as a conspicuous projection. The hind femora could scarcely be regarded as dentate, although the subangulate appearance of its middle is quite distinct, and is somewhat enhanced by a few setae; the middle tarsi are rather strongly inflated, but less so than the front ones, the hind claws are missing, but each of the others has a large, obtuse, basal appendix; on this, as on others of the close allies of *H. brevicollis*, the clothing of the onychium on each claw joint is rather dense, so that it is not always easy to see the shape of the claws, but they are always appendiculate, the appendix large and membraneous. The upper surface of the type (except for the lateral fringes) is now entirely glabrous; it is evidently a male, probably the female has simple hind femora and less strongly dilated tarsi.

HETERONYX PHANOPHILUS, n.sp.

Castaneous; elytra, under surface, and legs slightly paler than prothorax, antennae flavous. Upper surface glabrous, except for marginal fringes, lower surface sparsely clothed.

Head rather large, with dense punctures of moderate size and individually distinct, slightly larger and denser, but otherwise much the same, on clypeus; clypeus on an even convexity with frons, margin slightly upturned and gently rounded. Antennae eight-jointed. Prothorax almost thrice as wide as the median length, front angles produced, hind ones obtuse, but not rounded (from above appearing sharply rectangular); punctures as large and almost as dense as on frons. Scutellum impunctate. Elytra with large punctures, mostly irregular, but in places with a distinctly lineate arrangement, about twenty-five irregular rows on each elytron. Metasternum with dense punctures, becoming sparse in middle; sides more than twice the length of sides of hind coxae. Pygidium with crowded punctures, about as large as on pronotum. Front femora finely serrated on part of under surface; front tibiae bidentate; basal joint of hind and middle tarsi about once and one half the length of the second, of the front tarsi thin and more than twice the length of the second; claws appendiculate. Length, 5.5-7 mm.

Hab.—Queensland: Cairns district, abundant at lights (H. Hacker, Dr. J. F. Illingworth and A. M. Lea), Kuranda (R. W. Armitage, in National Museum).

Allied to *H. brevicollis*, of Group 2, and at first glance looking like small specimens of *Ocnodus*, but the claws not simple. The front and middle tarsi are

not conspicuously inflated and padded as on several of the close allies of *H. brevicollis*, but they are slightly larger and rather more densely clothed than on the female; the club of the antennae is also slightly the larger on the male. The serrations of the front femora average about six, with a seta between each pair, but some manipulation is necessary for them to be seen clearly. The clypeus, perpendicularly to itself, appears to have the front truncated and the sides oblique, but from the usual point of view its margin appears to be gently rounded; immediately behind its suture the frons is without a narrow polished impunctate strip; although the punctures on the head are very dense they are scarcely crowded, as each is individually distinct and not confluent with any of the adjacent ones; there is a feeble transverse impression on each side of the prothorax of most of the specimens, but it could be easily overlooked. The prothoracic membrane is very short behind the eyes, and not traceable elsewhere; the elytra are without an apical one. The general colour is of a rather bright reddish-castaneous; some specimens are of a rather dark brown, on one of the larger specimens the head and prothorax are almost black, a few small ones are pale castaneous, but the elytra are always paler than the prothorax.

HETERONYX BREVICOXIS, n.sp.

Almost black; elytra blackish-brown, parts of under surface and of legs obscurely paler, antennae and palpi pale castaneous, club flavous. Upper surface glabrous, except for straggling lateral fringes.

Head rather large and convex, with sharply defined and moderately dense punctures, becoming larger and crowded on clypeus, a narrow shining and almost impunctate strip immediately behind clypeal suture. Clypeus with outer margin rounded and slightly upturned. Antennae eight-jointed. Prothorax about thrice as wide as the median length, front angles moderately produced, hind ones slightly obtuse, but not rounded off (from above appearing sharply rectangular); punctures about as large as on back part of head, and moderately dense, but not crowded, becoming sparser on sides. Scutellum impunctate. Elytra with large punctures in more or less regular rows (about twenty on each elytron), but becoming irregular about apex. Metasternum with dense punctures, becoming sparse in middle, sides thrice the length of sides of hind coxae. Pygidium with larger and somewhat denser punctures than on pronotum. Front femora finely serrated on under surface; front tibiae bidentate; basal joint of hind tarsi about twice as long as second; claws appendiculate. Length, 7-8 mm.

Hab.—Queensland: Cairns and Kuranda (H. Hacker), Mossman (Dr. J. F. Illingworth).

Allied to *H. brevicollis*, of Group 2, and in general appearance quite close to *Ocnodus unidentatus*, but claws not simple; from the larger and darker specimens of the preceding species it is distinguished by the shining strip behind the clypeal suture; the punctures on the pronotum and frons are denser than usual, but not as dense as on that species. The base of the prothorax is but feebly bisinuate, but the median lobe projects backwards more than is usual in the close allies of *H. brevicollis*. Viewed perpendicularly, the clypeus appears to be truncated across the apex, with oblique sides, but from behind its slightly raised margin appears almost semi-circular, with the middle feebly produced; although the lineate arrangement of the elytral punctures is quite distinct, and sometimes two rows seem almost regularly geminate, no row is even throughout. The elytra are without an apical membrane; on the pronotum the membrane is very

short behind the eyes, and not traceable elsewhere. Two specimens, from Kuranda, are rather smaller and paler (dark reddish-castaneous) than the type, and have a few small punctures on the sides of the scutellum, but otherwise they agree well with it.

HETERONYX INCONSTANS, n.sp.

Black or blackish; parts of under surface paler, legs pale castaneous, antennae flavous. Upper surface glabrous, except for feeble lateral fringes, metasternum glabrous, except for a few median setae.

Head rather large and convex, with sharply defined punctures of moderate size and fairly dense, but evenly spaced, a polished impunctate strip behind clypeal suture; clypeus with outer margin slightly upturned and semi-circular; punctures larger and closer together than on frons, although not confluent. Antennae eight-jointed. Prothorax fully thrice as wide as the median length, front angles acute, hind ones slightly more than right angles, but appearing acutely rectangular from above, punctures slightly larger, sparser and less evenly spaced than on frons. Scutellum with fairly numerous and small sharply defined punctures. Elytra with more or less regular rows (less than twenty on each elytron) of fairly large punctures, smaller close to suture than elsewhere, and irregular on apical slope. Metasternum with dense punctures, becoming sparse in middle; sides almost thrice the length of sides of hind coxae. Pygidium with crowded punctures. Front femora feebly serrated on part of lower surface; front tibiae bidentate; hind tarsi with basal joint about once and one half the length of second; claws each with a large basal appendix. Length, 6-7 mm.

Hab.—Queensland: Coen River (W. D. Dodd and H. Hacker), Stewart River (Dodd).

A black or blackish species, allied to *H. brevicollis*, of Group 2; from the preceding species it differs in being smaller, with sparser punctures, and elytra less parallel-sided. The male has more numerous setae on the under surface of the front tarsi, but otherwise there appear to be no external distinctions of sex on the eight specimens under examination. Seen from behind, the front of the clypeus appears to be very feebly trilobed, the median lobe sometimes slightly advanced. One specimen has the upper surface entirely black, on one only the scutellum is obscurely reddish, on another the scutellum and a spot on each side of pronotum are obscurely reddish, on one the upper surface is dark piceous-brown, but the prothoracic margins, shoulders, and scutellum are reddish; one has the upper surface entirely bright castaneous; the metasternum and elytral epipleurae are usually paler than the abdomen.

HETERONYX NOCTIVAGUS, n.sp.

Bright castaneous, under surface and legs somewhat paler than upper surface, antennae flavous. Upper surface glabrous, except for loose marginal fringes.

Head rather large and convex, with fairly large, evenly spaced, and moderately dense punctures, but absent from a narrow shining strip immediately behind clypeal suture; clypeus with margins feebly elevated, truncated across apex; punctures denser and somewhat larger than on frons, but not confluent. Antennae eight-jointed. Prothorax thrice as wide as long, front angles acute, hind ones somewhat obtuse (appearing sharply rectangular from above); punctures about as large as on frons, but less numerous, an impunctate median line on basal half. Scutellum impunctate or almost so. Elytra with larger punctures than on pronotum, and mostly in rows (about twenty on each elytron), which

in places are quite regular, but very irregular about sides, apex and suture. Metasternum with crowded sub-asperate punctures, becoming sparse in middle; sides more than twice as long as sides of hind coxae. Pygidium with rather large and dense punctures. Front femora slightly serrated on middle of under surface, front tibiae bidentate; hind femora sub-angulate at middle of under surface and with a loose fascicle there; basal joint of each tarsus distinctly longer than second, each claw with a large basal appendix. Length, 5.5-6 mm.

Hab.—Queensland: Cairns, to lights (Dr. J. F. Illingworth).

Allied to *H. brevicollis*, of Group 2; that species is a consistently paler one, with the median projection of the clypeus (viewed from behind) more conspicuous and in advance of the lateral ones, the punctures coarser and more irregular, and the second tooth of the front tibiae larger and more projecting; *H. harpalinus* has also the median projection (viewed from behind) more advanced, and with coarser punctures on the pronotum and elytra. The clypeus, as viewed from behind, appears feebly trilobed, but the lateral lobes not posterior to the median one, as on *H. inconstans* when so viewed, its base (ocular canthus) on each side also projects distinctly outwards on a separate curve. The feeble angulation of the hind femora (a masculine feature) is rendered quite conspicuous by the loose fascicle and is somewhat suggestive of *H. clypealis*, but the clypeus is very different; on the present species its marginal elevation is nowhere very high, but is distinctly higher at the front angles than in the middle; on that species the elevation is greatest at the middle, and the elevated part averages almost thrice that of the present species; there are numerous other differences in the outlines, punctures, etc. Three specimens, all males, are under examination; their front and middle tarsi are slightly dilated and are rather densely padded, but much less so than on the males of *H. unidentatus*.

Heteronyx transversopolitus, n.sp.

Dark castaneous-brown; under surface and legs somewhat paler, antennae flavous. Upper surface glabrous, except for straggling lateral fringes.

Head rather large and convex; frons with rather sparse and not very large, but sharply defined, punctures, a narrow polished impunctate strip immediately behind clypeal suture; clypeus with larger and crowded punctures, margin slightly elevated. Antennae eight-jointed. Prothorax thrice as wide as the median length, front angles produced and acute, hind ones obtuse (from above, appearing sharply rectangular); punctures sparser and smaller than on frons. Scutellum with marginal punctures. Elytra somewhat dilated posteriorly, with large punctures in places in fairly regular rows (about twenty on each elytron). Metasternum with crowded punctures, becoming sparse in middle, sides thrice as long as sides of hind coxae. Pygidium with dense and rather large punctures. Front femora with a serrated, sub-dentiform projection in middle of under surface; front tibiae bidentate, the second tooth close to the first; front tarsi longer and thinner than the others; basal joint of each tarsus much longer than the second; each claw with a large, obtuse appendix. Length, 7-8 mm.

Hab.—Queensland: Innisfail (Dr. J. F. Illingworth), Cairns (H. Hacker).

Allied to *H. brevicollis*, of Group 2, and, of the closely allied species with bidentate front tibiae, it is distinguished by the comparatively sparse and small, although sharply defined, punctures on the frons, and the still smaller and sparser ones on the pronotum; it is rather more dilated posteriorly than the others, except *H. inconstans*, which is a smaller species, with larger punctures on the disc

of pronotum. Perpendicularly to itself the margin of the clypeus appears truncated across the middle, and rounded on the sides; from behind it appears almost semi-circular, with the middle feebly produced; the polished space behind its suture is very conspicuous. To the naked eye the upper surface appears almost black.

HETERONYX UNIDENTATUS, n.sp.

♂. Of a more or less bright castaneous; antennae and parts of legs paler (sometimes flavous).

Head large; frons with fairly large and sharply defined, but not very dense, punctures, immediately behind clypeal suture a narrow shining impunctate space; clypeus with margins slightly upturned and gently rounded, punctures coarser than on frons and crowded. Antennae eight-jointed. Prothorax almost thrice as wide as the median length, front angles slightly produced, hind ones slightly more than right angles and not rounded off; punctures numerous, but not crowded, and about as large as on clypeus; apical membrane very short, even behind eyes. Scutellum with a few punctures. Elytra with more or less irregular, but fairly well defined, rows of large punctures. Metasternum with fairly numerous coarse punctures on sides, sparse in middle; sides about twice the length of sides of hind coxae. Pygidium with coarse crowded punctures, and a short median carina. Front tibiae unidentate, the apical projection long and acute, the inner spur with a hooked tip; front tarsi with four basal joints conspicuously inflated, and (as also the fifth) densely padded on the under surface; middle tarsi slightly smaller, but otherwise much the same; basal joint of hind tarsi distinctly longer than second. Claws each with a large appendix. Length, 5-6.25 mm.

♀. Differs in having front and middle tarsi not dilated, and but sparsely clothed on the under surface.

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale).

A remarkable species, belonging to Blackburn's Group 2, where it could be placed with *H. brevicollis*, but which has the front tibiae bidentate; the inflated tarsi of the male associate the species with *H. harpalinus*, whose front tibiae are bidentate in both sexes, although described (in error) as unidentate in the female. The front of the clypeus, from above, appears to be truncated across the middle or gently rounded, but, from behind, its middle is seen to be slightly projecting (somewhat as on *H. inconstans*). At first glance the elytra, except for the lateral fringes, appear to be glabrous, but on close examination very minute sparse depressed pubescence may be seen. Nearly fifty specimens were obtained.

HAPLONYCHA FACETA Blackb.

Three specimens from the Swan River probably belong to this species. In Blackburn's table of Group 7 the type, now in the British Museum, is noted as having "Pronotum strongly and considerably less closely punctulate" than in *H. testaceipennis*; the three specimens have the prothoracic punctures larger and sparser than on that species, but they are certainly not coarse; the species is wider, the inter-ocular punctures are considerably larger and the apical slope of elytra is different; on *H. testaceipennis* the subsutural stria on each elytron is sharply defined to the apex, with the space between it and the suture distinctly convex; on the present species each subsutural stria practically vanishes on the apical slope, and the space between its position there and the suture is concave.

HAPLONYCHA FIMBRICOLLIS, n.sp.

♂. Reddish-castaneous; elytra (suture and margins excepted) paler and moderately iridescent. Sterna and base of abdomen with dense, pale hair, prothorax fringed all round with long erect pale hairs; pygidium with rather sparse and short hairs on disc, the tip with a long reddish fringe, propygidium with dense short setae or pubescence, and a few stiff hairs.

Head somewhat flattened between eyes; with rather dense and moderately large punctures. Clypeus somewhat swollen immediately in front of its suture; punctures there dense and rather large, rapidly becoming sparser and smaller in front. Antennae nine-, club three-jointed, joints of the club extending to about the middle of basal joint. Palpi with apical joint somewhat depressed and punctate in middle, penultimate joint distinctly shorter than ante-penultimate. Prothorax about four times as wide as long, sides strongly rounded posteriorly, front angles sub-acute, hind ones rounded off; with small, sparsely distributed punctures, gutters wide and filled with small piliferous granules; apical membrane long. Elytra widest at about the middle, with rather sparse punctures, small and rather sharp ones, and larger and shallower ones; with feeble longitudinal elevations marking the positions of geminate rows of punctures, but these feeble and in places absent. Pygidium with small scattered punctures; propygidium opaque and densely punctate. Basal joint of hind tibiae slightly shorter than second. Length, 24-25 mm.

Hab.—Western Australia: Busselton, Kellerberrin (J. Clark).

In Blackburn's table would be associated with *H. trichopyga*, of Group 2, but is at once distinguished by the apical joint of the maxillary palpi; on that species it is long, thin, subcylindrical in section, and no part is opaque; on the present species it is shorter, with a sub-opaque punctate depression representing a remnant of the conspicuous groove of species of Group 3. The erect hairs on the margins of the prothorax are unusually long, and the basal fringe is somewhat obscured by long hairs protruding from the base of the mesonotum; the elytra have a downward projecting fringe of very short golden setae, distinct across apex, and traceable to base; in addition, each side has a fringe of outwardly projecting stiff, reddish setae, fairly long at the base, becoming shorter posteriorly, and not traceable across apex. The third and fourth joints of antennae are of equal length, the sixth is very short; the sublateral foveae of the pronotum are wide but shallow, and on each specimen have the appearance as of being irregularly impressed. The specimen from Kellerberrin has the palpi broken off, and most of the hairs missing from the apex of prothorax, but evidently belongs to the same species.

HAPLONYCHA FIMBRIPENNIS, n.sp.

Reddish-castaneous; elytra (suture and margins excepted) and most of abdomen flavous. Sterna densely pilose, a fringe of rather distantly placed hairs on each side of prothorax, pygidium with fairly numerous short hairs.

Head with punctures of moderate size, somewhat crowded near eyes and clypeal suture, sparser elsewhere. Antennae nine-, club four-jointed, fifth joint triangularly produced on one side, first joint of club three-fourths the length of second, and almost as long as four preceding joints combined. Apical joint of palpi rather thin, with an oblique punctate depression, extending for about two-thirds the length on its upper surface, penultimate joint distinctly shorter than ante-penultimate. Prothorax about thrice as wide as the median length, sides

evenly rounded, front angles produced and acute, hind ones rounded off, punctures rather sparse and small. Elytra widest at about basal two-fifths, each with four feebly elevated but distinct longitudinal ridges, marking geminate striae; punctures not very closely placed (even in striae), with numerous feeble oblique impressions. Pygidium large, with a feeble but almost continuous median ridge, surface somewhat rugose, especially about base, where the punctures are somewhat crowded. Basal joint of hind tarsi slightly shorter than second. Length, 30 mm.

Hab.—Western Australia: Northam.

Each side gutter of the pronotum with but a single row of rather distant, piliferous punctures, excludes this species from Blackburn's Group 2, so by its palpi it must be referred to Group 3; it is much larger than any other species of the latter group, and in general appearance is strikingly close to *H. latebricola*, and *H. longipalpis* (Group 2), *H. colossa* (Group 4), and *H. gigantea* (Group 5). In addition to the very short downward projecting fringe, each margin of the elytra has a fringe of outwardly projecting setae, becoming irregular and more numerous (not in a single row) about base. The type is probably a male.

HAPLONYCHA TARSALIS, n.sp.

♂. Flavous; head reddish-castaneous, its base, base and apex of prothorax very narrowly, scutellum, elytra (wholly or in part), most of abdomen and parts of legs black, or deeply infuscated. Sterna moderately pilose, parts of upper surface with a few hairs.

Head with sharply defined punctures of moderate size, denser about clypeal suture than elsewhere; clypeus with sides less narrowed to apex than usual. Antennae nine-, club four-jointed. Palpi with apical joint moderately long, with a conspicuous elliptic depression on its upper surface; two preceding joints shorter than usual. Prothorax between three and four times as wide as its median length, strongly convex, base rather strongly sloped, sides strongly rounded, front angles slightly produced and almost rectangular, hind ones rounded off; with fairly numerous punctures of moderate size. Elytra widest at about basal third; punctures denser and larger than on prothorax, with feeble remnants only of longitudinal elevations and geminate striae. Pygidium moderately large; with numerous shallow, rugose punctures of moderate sizes or small. Front tarsi with claw joint large, and each claw suddenly bent backwards at the middle, and with a large sub-basal appendix; basal joint of hind tarsi slightly longer than second. Length, 12-13 mm.

Hab.—North-western Australia: Wyndham, Forrest River.

The smallest known species of Group 3; in Blackburn's table it would be associated with *H. setosa*, which has denser punctures and is very differently coloured; in its abnormal front claws it approaches *H. marginata*, of the same group, in which they are still more abnormal in the male; they somewhat resemble those of *Macropocopris*, the species of which live in the fur about the anus of wallabies. The dark parts of the elytra vary considerably in extent; on one specimen most of its elytra is pale, on the type the elytra are entirely dark, although the median parts show a faint decrease of colour, the third specimen is intermediate; the hind tibiae also vary in colour. Probably on fresh specimens the base, apex and sides of pronotum are all sparsely fringed with hairs, as remnants of fringes are to be seen on all three specimens; there are a few long hairs on the elytra near the scutellum, and some shorter ones posteriorly; there

are also a few hairs on the pygidium. The outward projecting fringe of elytral setae is distinct on each side almost to the apex; but the downward projecting fringe is composed of such extremely short setae that it appears as a scarcely visible whitish rim.

HAPLONYCHA PALLIDA, n.sp.

Pale flavous; part of head, elytral suture and parts of appendages faintly tinged with red. Sterna and base of abdomen moderately pilose; prothorax with feeble fringes of hair on sides, base, and apex; elytra with a few short scattered hairs, each side with a fringe of hairs or reddish setae from near apex to base, where they are longest; pygidium fringed with hairs, four segments of abdomen each with an interrupted row of hairs.

Head with dense and well defined punctures, rapidly becoming smaller on clypeus. Antennae nine-, club four-jointed. Apical joint of palpi moderately long and subcylindrical, an elongate, narrower, slightly depressed, opaque space on upper surface. Prothorax between three and four times as wide as head, sides evenly rounded, front angles feebly produced and almost rectangular, hind ones rounded off, punctures fairly numerous but not dense (more numerous close behind sub-apical furrow than elsewhere) and sharply defined although rather small; apical membrane moderately long close to sides, but very short elsewhere. Elytra almost parallel-sided to near apex, surface in places slightly rugose; and hence causing the punctures to appear irregular, ridges marking the geminate rows of punctures feeble, the rows also feeble; suture briefly mucronate. Pygidium subtriangular, with sparse and small punctures, but becoming crowded at base; propygidium opaque and densely punctate, but apex shining. Basal joint of hind tarsi longer than second. Length, 13-14 mm.

Hab.—South Australia: Ooldea.

The depression on the apical joint of palpi is too feeble (although from certain points of view it is quite distinct) to be regarded as associating the species with the members of Group 3; the penultimate joint on two specimens appears to be slightly longer than the ante-penultimate, but on the type and another specimen the palpi are clearly visible, and the penultimate one is seen to be the longer, the species, therefore, belongs to Blackburn's Group 5, the sides and base of pronotum are very feebly fringed, so it could hardly be associated with *H. mauricei* (on one specimen the basal fringe cannot be traced), which is a larger and darker species, with much coarser punctures on clypeus, with well defined geminate rows of punctures on elytral and conspicuous prothoracic fringes; passing that species, it would be associated with *H. arvicola*, from the description of which it differs in its much smaller size, pale colour, etc. Had but one specimen been taken, it would probably have been considered immature. but the four specimens agree perfectly in colour.

HAPLONYCHA PULCHRIPENNIS, n.sp.

Bright reddish-castaneous, elytra somewhat paler and with a slight pruinose iridescence. Sterna with dense pale hair, prothorax with a thin fringe of hairs on each side, continued for a short distance only around base and apex; pygidium with a thin fringe of setae, and a few shorter ones on disc.

Head with sharply defined punctures of moderate size, becoming denser and larger about clypeal suture, the intervening spaces with minute punctures; front face of clypeus with an irregular row of piliferous punctures close to labrum,

and some irregular ones elsewhere. Antennae nine-, club three-jointed, joints of club about as long as three basal joints combined. Apical joint of palpi slightly curved, its upper surface with an oblique, flat (scarcely depressed), opaque, punctate space; penultimate joint slightly shorter than ante-penultimate. Prothorax about three and one half times as wide as the median length, sides strongly rounded, front angles produced and rectangular, hind ones strongly rounded off, apical furrow strong throughout, but especially near sides; punctures rather sparse and small, but sharply defined; apical membrane long behind eyes, short elsewhere. Elytra rather strongly dilated posteriorly; punctures rather numerous and of moderate size, becoming smaller and denser about tips, geminate rows well defined, the ridge between each pair feebly elevated and distinct, and with few or no punctures; suture unarmed. Pygidium strongly convex, base with dense and small punctures, sparse elsewhere. Basal joint of hind tarsi slightly longer than second. Length, 24 mm.

Hab.—Victoria: Wangaratta (Aug. Simson).

It is somewhat dubious whether this beautiful species should be referred to Blackburn's Group 6 or Group 7; if to the former, it could scarcely be placed with *H. clara* (which is a considerably smaller and paler species), as the fringe of long hairs on each side of the prothorax stops abruptly a short distance within the base, so it would probably be associated with *H. thoracica*, from the description of which it differs in being much larger, with small prothoracic punctures, etc.; if referred to Group 7, it would be associated with *H. testaceipennis* (although I cannot regard the pronotum of that species as "closely punctulate"), from which it differs in being much larger, more castaneous, head with coarser punctures, etc.; in size and general appearance it is more or less close to *H. dubia*, *H. campestris*, *H. pilosa* (Group 2) and *H. gouldi* (Group 4). The sixth joint of the antennae is unusually thin and, from certain directions, can scarcely be seen. Each front angle of the prothorax, from above, appears to be decidedly acute, but, from a point perpendicular to itself, is seen to be rectangular. Each elytron has a fringe of very short, downward projecting, golden setae, from the suture (where the tip of an internal fringe of longer setae is visible) around the side to the hind coxa; it then changes to longer and soft hairs, and shortly after passing the coxa abruptly ends; the outward projecting fringe of reddish bristles is fairly long at the base, becomes short posteriorly and terminates level with the pygidium. Judged by its long club the type appears to be a male.

HAPLONYCHA FIMBRIATA, n.sp.

Castaneous-red; elytra (suture and margins excepted) flavous, prothorax and scutellum opaque, rest of upper surface slightly shining. Sterna with dense pale hair; prothorax completely fringed with short upright hair, each side, in addition, with a thin fringe of longer hairs; elytra with very short hairs or sparse pubescence about the sides and tips; abdomen with dense and rather long reddish setae on sides, sparse and short in middle; pygidium with numerous short setae on disc, and fringed with longer ones; propygidium with a rather dense, but normally concealed, fringe.

Head with dense and comparatively small, but sharply defined, punctures, becoming larger about clypeal suture; clypeus rather longer than usual, its suture bisinuate. Antennae nine-, club three-jointed, joints of club about as long as two basal joints of antennae combined. Apical joint of palpi moderately long and rather thin, penultimate joint shorter than ante-penultimate. Prothorax fully

four times as wide as long, sides strongly rounded (almost sub-angularly dilated), front angles produced and sub-acute, hind ones not rounded off; punctures small and rather sparse; apical membrane rather long behind eyes, short elsewhere. Elytra moderately dilated posteriorly; suture very feebly mucronate. Basal joint of hind tarsi longer than second. Length, 17-18 mm.

Hab.—Western Australia: Swan River (J. Clark).

The large piliferous punctures across the front face of the clypeus, immediately above the labrum, are very distinct, but they are not quite regular, and, seen from the sides, there are other setae or hairs as well, so it is somewhat doubtful whether the species should be referred to Group 6 or Group 7; if to the latter, in Blackburn's table, it would be associated with *H. testaccipennis*, from which it is distinct by its opaque prothorax (much as on *H. opaca*), much denser punctures on head and less sharply defined elytral punctures; if referred to Group 6, it might be placed with *H. clara*, although the hairs in the basal gutter are short; that species has somewhat similar outlines, but its elytra are darker than on the present species, its prothorax is not opaque, and it has crowded punctures. On the type the elytral fringes are in perfect condition; on each side the outward projecting one at the base consists of rather long, sparse, reddish bristles; these soon change to shorter and denser ones, and are so continued to about the abdomen, when they begin to turn downwards, till on the apex they are vertical, but for a short distance after and before the sub-apical segment, they also change in thickness, so as to resemble rather elongate scales; the downward projecting fringe of very short setae is concealed by the longer fringe at and near the apex, but elsewhere appears as a very short whitish margin. On a second specimen, the fringes have been partly disarranged and abraded, disclosing the fact that the true edge of each elytron is minutely serrated almost throughout. On the type the elytral punctures (including the geminate rows) and longitudinal elevations appear to be very feeble; but on parts of the other specimen, the punctures appear to be fairly large and quite sharply defined; but it is slightly greasy, the grease causing the disappearance of the natural "bloom" that more or less conceals the punctures and causes the opaque appearance of parts of the upper surface.

Lepidiota trichosterna, n.sp.

Bright castaneous; some marginal and projecting parts (especially on the legs) darker, tibial teeth black. Rather sparsely clothed with thin, depressed, elongate, white scales or stout setae, denser on head and scutellum than elsewhere, thinner on pygidium and still thinner on propygidium; sterna and hind coxae with long and dense pale hair; longer, stouter and sparse on legs, but mixed there with stout setae-like scales, as on prothorax.

Head with coarse punctures, an obtuse longitudinal ridge in middle. Clypeus well elevated in front and scarcely bilobed, punctures evenly distributed. Antennae with club rather small. Apical joint of palpi elongate, sub-elliptic, on outer side with a narrow, flat or feebly concave, sub-opaque space. Prothorax with all angles somewhat acute, sides widest near middle; with wide, but obtuse, crenulations, front and hind margins not beaded; punctures about as large as on head, but somewhat unevenly distributed. Elytra moderately dilated to beyond the middle, each with five feeble, longitudinal elevations, of which the fourth (counting from the suture) is very feeble; punctures smaller than on prothorax, but quite as deep, larger about tips than elsewhere. Propygidium with crowded and small punctures about base, becoming sparser and larger posteriorly,

and somewhat larger on pygidium. Front tibiae strongly tridentate, median tooth slightly nearer first than third. Length, 23 mm.

Hab.—Queensland: Gin Gin (Easterby).

In general appearance nearer the species of *Paralepidiota* and *Pararhopaea*, than *Lepidiota*, but club three-jointed. In Blackburn's table, it would be placed in A, BB, from all the species of which it is very distinct. There are no round scales on any part of the body.

LEPIDIOTA PLATYURA, n.sp.

Blackish-brown and sub-opaque; elytra pale castaneous-brown, becoming much darker on basal third; antennae, palpi, and tarsi castaneous. Upper surface with circular or briefly elliptic, snowy scales, closely applied to derm, becoming less rounded, but quite as flat, on abdomen and hind parts; sterna and hind coxae with dense, pale hair.

Head from half-way between eyes to apex with dense round punctures, but not encroaching upon each other, near clypeal suture not as dense as elsewhere. Clypeus strongly bilobed, margins moderately upturned. Antennae with joints of club almost the length of funicle. Apical joint of palpi elongate, sub-elliptic, with a fairly deep narrow impression. Prothorax widest at about basal third, sides obtusely crenulated, front gently incurved and with a narrowly raised margin, front angles almost rectangular; hind angles very obtuse, angles with round crowded punctures, becoming sparser and smaller towards middle, but even there fairly numerous. Elytra slightly dilated about middle; with punctures much as on disc of pronotum, without distinct longitudinal lines. Abdomen and propygidium with small, crowded punctures, becoming somewhat sparser, but still dense, on pygidium, the latter unusually large and wide (9 x 6 mm.). Front tibiae strongly tridentate, the median tooth equidistant from the others. Length, 25 mm.

Hab.—Queensland: Cape York (C. French).

In Blackburn's table, this species would be associated with *L. negatoria*, from the description of which it is distinguished by the obtuse hind angles of pronotum; the pygidium is much wider than in *L. frenchi* and *L. perkinsi*, and decidedly wider than is usual in the genus. The upper surface, to the naked eye, has a curious mealy appearance. On the head, from between the middle of the eyes to the front, the scales are quite circular, and each is contained in a puncture; on the type, the base of the head is exposed and highly polished, but would normally be concealed; at the place where the apparent base would normally be exposed the scales are smaller and denser than elsewhere, so that the surface, especially close to the eyes, is completely plated; they almost completely fill the angles of the pronotum and become sparser and smaller in the middle, but still quite circular; on the elytra they are almost evenly distributed, but vary somewhat in size and slightly in outlines; they almost completely cover the abdomen and propygidium, and are dense on the pygidium. The hair on the under parts is depressed on the type, but this may be due to improper treatment; there are long pale hairs and stout white scales on the legs.

LEPIDIOTA RUGOSIPENNIS, n.sp.

Dark castaneous-brown; parts of head, extreme base of prothorax, elytral suture very narrowly, and tibial teeth black or blackish. Moderately clothed with small snow-white scales, circular or almost so on head and prothorax, pointed on

elytra and scutellum; under surface and hind parts densely clothed with elliptic or pointed scales, front portion only of metasternum with yellowish hair; legs with straggling hairs and white scales.

Head with dense, round punctures, smaller and denser close to eyes than elsewhere. *Clypeus strongly bilobed, margins moderately upturned;* punctures dense and evenly distributed. Antennae with basal joint of club extending to apex of first joint of funicle. Apical joint of palpi moderately stout, tip incurved; on upper surface with an elongate, depressed or flattened opaque space. Prothorax moderately long, widest at about basal two-fifths, sides obtusely crenulated, front angles slightly produced and almost rectangular, hind ones rounded and obtuse, front and hind margins not elevated; with fairly large, but somewhat unevenly distributed, punctures; median line shining and distinct throughout. Elytra very feebly dilated about middle; punctures mostly larger than on prothorax, and many of them connected by transverse or oblique wrinklings of the derm. Hind parts with smaller and denser punctures than on upper surface. Front tibiae strongly tridentate, median tooth slightly nearer first than third. Length, 25 mm.

Hab.—Queensland: Cairns (E. Allen).

Structurally fairly close to *L. frenchi*, but scales of hind parts not circular, pygidium somewhat smaller and less transverse, hind coxae with true scales only, and punctures and palpi different. On parts of the under surface and of the pronotum of the type, many of the scales are slaty or yellowish, but such scales have probably been stained.

Pachytricha minor Sharp.

Miss J. F. May took several specimens of this species washed up on the beach at Cottesloe (near the Swan River).

Systellopus ater Lea.

Mr. J. Clark writes that the locality given for the type (Chillagoe) was wrong, and that it was obtained at the Chapman River, near Geraldton (Western Australia).

Enamillus mauricei Blackb.

A male, from Ooldea, agrees so perfectly in structure with normal males of this species that I cannot regard it as other than a variety; it differs, however, in having the clypeus, labrum, prothorax (an obscure spot on each side infuscated), scutellum (tip obscurely infuscated) elytra and most of under surface and of legs reddish.

DYNASTIDES.

Pseudoryctes validus Lea.

Four males from Broome (N. W. Australia) belong to this species; they have the prothoracic cavity glabrous and the medio-apical process of the prothorax notched at the tip, thus differing from the description of *P. dispar*, and from a specimen that agrees well with that description.

CETONIDES.

Cacochroa gymnopleura Fisch., var. fuscosuturalis, n.var.

Mr. R. Illidge has, from Gympie (Queensland), a male that agrees so perfectly in structure with the typical form of this species that I cannot regard it

as more than a variety; it differs, however, in having the head and prothorax black, with a faint coppery or bluish gloss, and the elytra flavous, with the suture widely infuscated from the base to the summit of the apical slope and narrowly on this to the apex itself, the shoulders are distinctly and the sides very faintly infuscated.

EUPOECILA AUSTRALASIAE Don., var. INTRICATA Lea.

This variety was named from a female, now in the National Museum, Melbourne. Mr. R. Illidge has recently taken, in the Queensland National Park, a male that agrees well with the figure (Trans. Roy. Soc. S. Aust., 1914, Pl. vii., fig. 22) except that the medio-basal markings on the pronotum are slightly larger.

DILOCHROSIS BROWNI Kirby.

A female from Darnley Island, received from Dr. E. W. Ferguson, evidently represents a variety of this species. Its prothorax is black, with the thickened margin pale from apex to near base, then the pale part on each side is turned inwards as a narrow line for about one-third of the width, the sides of the apex are also narrowly and irregularly pale; on the elytra an irregular basal space about equal to the length of the scutellum is black, and the sterna and abdomen are black.

METALLESTHES METALLESCENS Westw.

Messrs. R. J. Burton and A. H. Elston saw this species in abundance, on the flowering stems of a species of *Xanthorrhoea*, at Barossa (South Australia) in December.

ENTOMOSTRACA COLLECTED IN THE VICINITY OF AUCKLAND, NEW ZEALAND.

By Marguerite Henry, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Five Text-figures.)

[Read 30th July, 1924.]

Introduction.

This collection of Crustacea was obtained by Mr. T. Steel in May, 1917; he has very kindly allowed the writer to examine the specimens and has also provided some notes on the four localities from which they were obtained, Lake Takapuna, Onehunga Springs, a tarn on Mt. St. John and Duck Creek. Mr. Steel's notes are as follows:—

> "Lake Takapuna is a freshwater lake about two miles north of Auckland, it is half a mile in diameter and of considerable depth, since it occupies the crater of an extinct volcano of recent geological age. The material was obtained by the use of a fine hand-net round the margins where there is a plentiful growth of freshwater sponge.
>
> "Onehunga Springs are the outcome of seepage water from rain falling on the extensive lava plains between Auckland and Onehunga. The water bubbles up in a powerful stream at different points in an area of a quarter of a square mile; it is exceedingly clear and cool and water cress grows abundantly.
>
> "Mt. St. John is close to Auckland. It is an extinct volcano of recent geological age; in the centre of the crater is a permanent freshwater tarn about thirty feet in diameter. Bulrushes grow round the margin and the water contains immense numbers of Volvox.
>
> "Dam at the Duck Creek sugar works, Auckland Harbour, is formed in a gully and is about ten feet deep."

Various fixatives were employed by Mr. Steel; formalin, corrosive sublimate, Carl's fixative and chrome acetic, but the results did not differ to any appreciable extent. None of these fixatives are as satisfactory for the smaller Crustacea as glycerine alcohol.

In addition to Crustacea, the collection contained the larvae of numerous insects, pond snails, mites and Protozoa, a species of *Ceratium* predominating.

The Entomostraca were well represented, but, though the number of individuals was large, they only comprised ten species. Brady noted the same fact in 1906, "such a small number of species were found in so extensive a series of nettings from so many different lakes."

The literature on the New Zealand freshwater Entomostraca is not very ex-

tensive, the most important papers on the subject are those of Thomson, Sars and Brady. In 1878 and 1882, Thomson published two papers in the Proceedings of the New Zealand Institute, in which he described thirteen Entomostraca, several of which were new, collected in the vicinity of Dunedin and in the Canterbury district. In 1894, Sars described several species that had been raised from dried mud collected from the same localities, and also from Kaitaia in the North Island. In 1903, the same writer described a number of species from Lake Wakatipu and D'Urville Island. Brady's paper "On the Entomostracan fauna of the New Zealand Lakes" was published in 1906; his specimens were from more widely distributed localities, Lakes Waikare, Taupo, Rotoiti and Waikare Moana in the North Island, and Wakatipu and Manapouri in the South Island. In 1914, Archey recorded the presence of *Daphnia carinata* King at Christchurch and Oamaru.

The writer wishes to thank Mr. Steel for the opportunity of examining the collection, and also for his help and advice.

One species is described as new and the type specimen has been deposited in the Australian Museum, Sydney. The text-figures were drawn with the aid of a camera lucida; the finished drawings were prepared by Miss D. Harrison.

The following species were represented in the collection:—

CLADOCERA.

Family *Daphnidae*.—*Simocephalus obtusatus* (Thomson), *Ceriodaphnia sublaevis* Sars.

Family *Bosminidae*.—*Bosmina meridionalis* Sars.

Family *Chydoridae*.—*Chydorus barroisi* Richard, *Pleuroxus hastirostris* Sars.

COPEPODA.

Family *Centropagidae*.—*Boeckella triarticulata* (Thomson), *Brunella steeli*, n.sp.

Family *Cyclopidae*.—*Mesocyclops obsoletus* (Koch).

OSTRACODA.

Family *Cyprididae*.

Subfamily *Cypridinae*.—*Cypretta globulus* Sars.

Subfamily *Herpetocypridinae*.—*Candonocypris candonoides* King.

CLADOCERA.

Genus Simocephalus Schoedler, 1858.

Simocephalus obtusatus (Thomson).

Daphnia obtusata Thomson, Trans. N.Z. Inst., 1878, p. 261.—*Simocephalus obtusatus* Sars, 1894.

Both males and females were present in the collection from Lake Takapuna. This species has not been recorded outside New Zealand; both Thomson's and Sars' specimens came from Dunedin in the South Island. Brady records it from Lakes Waikare and Rotoiti.

Genus Ceriodaphnia Dana, 1853.

Ceriodaphnia sublaevis Sars.

Sars, Contributions to the knowledge of the Freshwater Entomostraca of New Zealand, 1894.

A few specimens of this species were present in the collection taken from the dam at Duck Creek; they were below the average in size, but otherwise

corresponded with Sars' description. This is another species unrecorded outside New Zealand.

Distribution.—New Zealand: North Island, Duck Creek near Auckland; South Island, Dunedin.

Genus Bosmina Baird, 1845.

Bosmina meridionalis Sars.

Sars, Pacifische Plankton—Crustaceen, 1903, p. 631.

This species was present in great abundance in the collections from Lake Takapuna and the dam at Duck Creek. Its distribution is widespread throughout New Zealand. Sars' specimens were from Lake Wakatipu and Brady has recorded it from Lakes Waikare, Taupo, Rotoiti and Waikare Moana in the North Island, and Wakatipu and Manapouri in the South. It has not been recorded outside New Zealand.

Genus Pleuroxus Baird, 1843.

Pleuroxus hastirostris Sars.

Sars, Pacifische Plankton—Crustaceen, 1903, p. 635.

The collections from Onehunga Springs, Lake Takapuna and Duck Creek contained many specimens of this species. Hitherto it has only been recorded from D'Urville Island, New Zealand.

Genus Chydorus Leach, 1843.

Chydorus barroisi (Richard) var. laevis Sars.

Pleuroxus barroisi Richard, "Cladocère recueilles en Syrie et en Egypt," 1894, p. 16.—Var. *laevis* Sars, Pacifische Plankton—Crustaceen, 1903, p. 636.

A single specimen of this species was present in the collection from Onehunga Springs.

Distribution.—New Zealand: D'Urville Island, Onehunga Springs. North and South America, Africa, Palestine.

COPEPODA.

Genus Boeckella De Guerne and Richard, 1889.

Boeckella triarticulata (Thomson).

Boeckia triarticulata Thomson, "On the New Zealand Copepoda," 1882, p. 94.

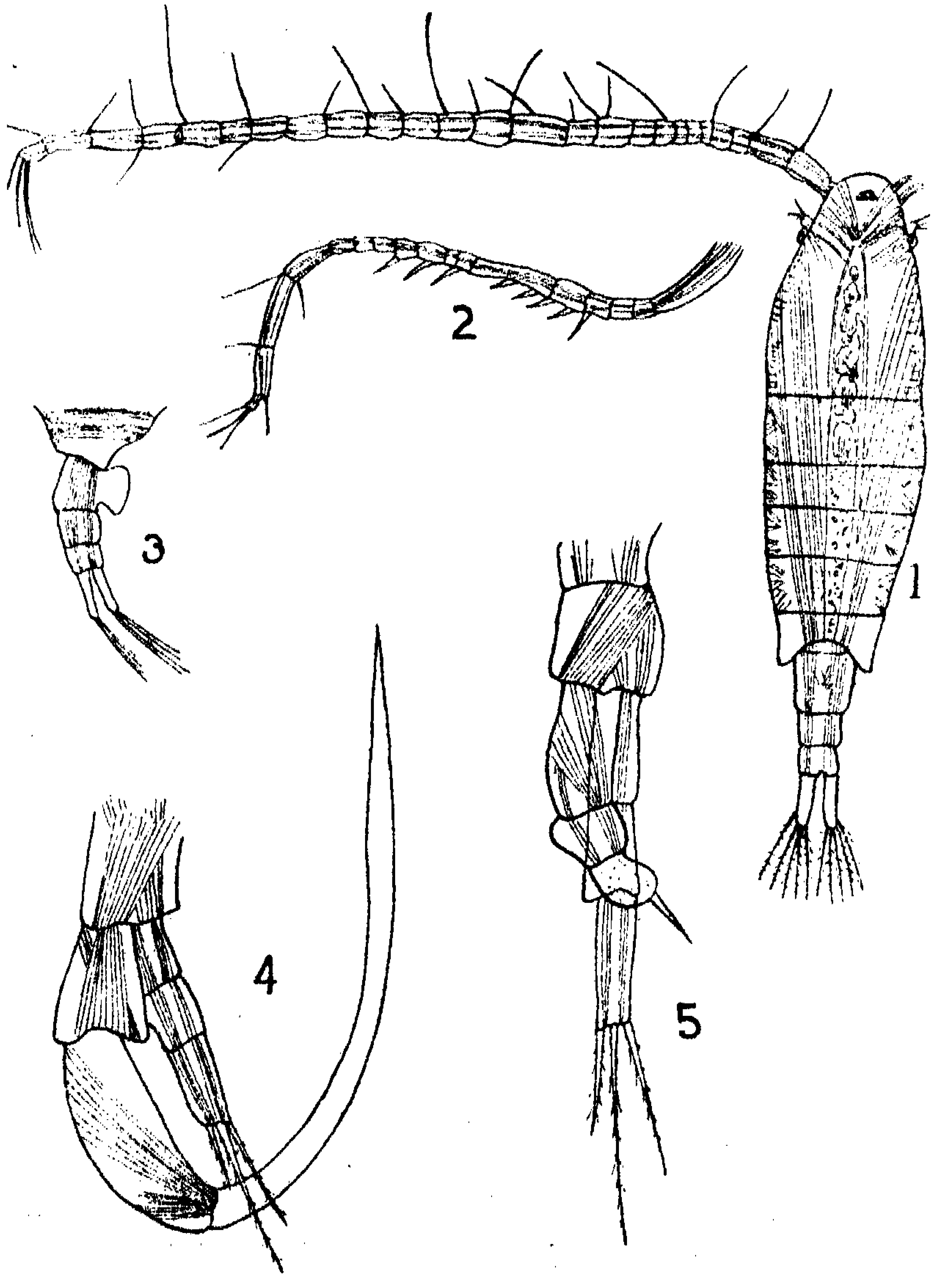
This species was abundant in the collections from Lake Takapuna, Onehunga Springs, Duck Creek and the tarn on Mt. St. John. It occurs throughout the North and South Islands of New Zealand and also in Australia.

Genus Brunella Smith, 1909.

Brunella steeli, n.sp. (Text-Figs. 1-5.)

Female (Fig. 1): Body slender, cephalothorax narrowly oval, the greatest width occurring immediately in front of the middle, tapering anteriorly and posteriorly. Head narrowly rounded in front, with a small rostral prominence. Lateral expansions of the last pedigerous segment of moderate size, tips blunt, right expansion broader than the left. Urosome (Fig. 3) comparatively short, not attaining half the length of the cephalothorax; genital segment asymmetrical, bearing a large protuberance on the ventral surface; second segment larger than the third, but not as long as the genital segment. Caudal rami long and slender,

not quite attaining the length of the two preceding segments combined; each ramus bearing five feathered setae at its slightly dilated extremity, setae of almost equal length. Antennules composed of twenty-five segments, elongated and slender, extending, when reflexed, beyond the tips of the caudal setae. Antennae with the inner ramus equal in length to the outer, the latter composed of six



Text-figs. 1-5.—*Brunella steeli.*

1. Female (x 85). 2. Right antennule of male (x 70). 3. Urosome, female (x 70). 4. Right leg of 5th pair, male (x 200). 5. Left leg of 5th pair, male (x 200).

segments, the last being very long. Oral parts of normal structure for the genus. First pair of legs smaller than the succeeding ones; outer ramus consisting of three segments; inner ramus small, one-segmented. Next four pairs with an outer ramus of three and an inner ramus of two segments; fifth pair with a stout curved process on the middle segment of the outer ramus. Length, 0.81 mm.

Male slightly smaller than the female and differing from it in having a hinged right antennule (Fig. 2) with a slightly swollen middle portion; a slender urosome composed of five segments and in the structure of the last pair of legs. Fifth pair of legs with the left leg (Fig. 5) shorter than the right, its outer ramus composed of three segments, the last being rounded and armed with a short spine; inner ramus longer, composed of two segments, the terminal one bearing long feathered setae. Right leg (Fig. 4) with an outer ramus composed of two broad segments, the second segment being twice as long as the first, and bearing a long curved spine, its end pointing towards the base of the leg; inner ramus composed of three segments, the terminal one bearing setae of unequal length.

Distribution.—New Zealand: North Island, Duck Creek and Lake Takapuna.

The species is a comparatively small one and is the first member of the genus *Brunella* to be recorded from New Zealand. The writer has much pleasure in naming it after its collector, Mr. Steel.

Genus Mesocyclops Sars, 1914.

Mesocyclops obsoletus (Koch).

Koch, "Deutschlands Crustaceen, Myriapoden und Arachniden," 1835.

This species was abundant in the collections from Lake Takapuna, Mt. St. John and Duck Creek. It is of world wide distribution and is a common form in Australia.

OSTRACODA.

Genus Cypretta Vavra 1895.

Cypretta globulus (Sars).

Cypridopsis globulus Sars, "On some Freshwater Ostracoda and Copepoda raised from Dried Australian mud," 1889.

Many specimens of this species were present in the collections from the tarn on Mt. St. John, but none were found in those from the other localities.

Distribution.—New Zealand, Australia.

Genus Candonocypris Sars, 1894.

Candonocypris candonoides (King).

Cypris candonoides King, "On Australian Entomostracans," 1855, p. 66.—*Herpetocypris stanleyana* Sars, 1889.—*Candonocypris candonoides* Sars, 1894.

A few specimens were present in the collections from Mt. St. John; these agreed with Sars' description, except that their valve margins were fringed with hairs throughout their length, instead of having them confined to the extremities.

Distribution.—New Zealand: Dunedin and Eyreton in the South Island, Mt. St. John in the North. Australia; South Africa.

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NOTES ON BREEDING ENTOMOSTRACA FROM DRIED MUD AND THEIR HABITS IN AQUARIA.

By MARGUERITE HENRY, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

[Read 30th July, 1924.]

Introduction.

This series of experiments was commenced, partly as a means of studying the habits of various Entomostraca, but principally to obtain specimens from localities whence it was impossible to collect them except in the form of eggs. It is well known that the eggs of most Entomostraca can resist prolonged desiccation, the longest case on record being that of eggs sent from Jerusalem to England and hatched after twenty-four to thirty years had elpased since the mud containing them had been dried. Many of our Australian Entomostraca were first described from specimens raised from dried mud that had been collected in Australia and sent to Professor Sars in Norway.

The experiments were carried on from June, 1921, until the end of March, 1924, and the following notes give the dates of appearance of the various species, the length of time they remained in the aquaria, and their relative prevalence.

The author wishes to thank many friends for samples of dried mud with which aquaria were prepared, and especially Sir Baldwin Spencer for much interesting material from Central Australia.

Preparation of Aquaria.

The aquaria were all prepared in the same way, the largest used were nine inches high and six inches across, but the majority were slightly smaller. The dried mud was placed at the bottom and the aquarium was then filled to within an inch from the top with tap water. A small piece of some water plant was then thoroughly washed and examined under the microscope, to prevent the eggs of local Entomostraca being introduced into the aquarium; the plant, *Elodea*, *Chara* or *Nitella*, was then placed in the mud or, if *Lemna* was used, on the surface of the water, and in most cases grew quickly; sometimes, however, the mud contained a large proportion of salt, which in time rendered the water so highly saline that the plants died. The presence of plants is necessary to aerate the water and prevent putrefaction, but they are apt to grow too vigorously and fill the aquarium; to regulate their growth, two or three pond snails were placed in each aquarium. In order to accelerate the hatching process, the aquaria were placed where they could receive the maximum amount of sunlight. They were always kept covered and, as a rule, only required additional water two or three times a year.

Résumé of the results obtained.

Only one specimen of Phyllopoda was bred out during these experiments. This scarcity is the more remarkable, since many of the samples of mud were taken from dried claypans and water holes where Phyllopoda had been abundant and in one case the mud contained numerous *Estheria* shells.

The Cladocera were well represented, especially the family *Daphnidae;* the species of this family showed a tendency to increase suddenly, with great rapidity, until the aquarium would be swarming with males and ephippial females. Shortly after this stage, a heavy mortality would occur, and sometimes the species would not again appear in the aquarium. Some Cladocera may apparently continue reproducing parthenogenetically for an unlimited period, so long as the conditions of their environment are favourable, but the Daphnidae in the aquaria invariably produced the sexual forms comparatively soon after their first appearance.

This may have been due to the large numbers, since Grosvenor and Smith have shown that crowding leads to the production of sexual forms, while, by isolating the parthenogenetic females at birth, at a temperature of 25°-30° C., the production of sexual forms may be entirely suppressed (Quart. Journ. Mic. Soc., 58, Part 3, 1913). There were never large numbers of Copepoda present, although several different species were represented. In some cases, numerous Calanoids appeared, but they were never the dominant feature and were not persistent.

One of the most noteworthy features of these experiments was the predominance of the Ostracod group. In nearly every case the first specimens to appear were Ostracods, in the exceptional cases a few Copepods appeared slightly earlier. The Ostracods also persisted after the other groups had disappeared from the aquaria, and could apparently be kept, under artificial conditions, for an unlimited period. The aquarium life may more closely resemble their natural environment than it does that of the other groups, and this is especially true in the case of the Copepoda.

Details of the experiments.

Aquarium No. I.

Mud collected at Drummond, South Island, New Zealand, by Dr. C. Chilton in 1914.

Species bred out: *Cypretta viridis* (Thomson).

Aquarium started 15th June, 1921.

The first Ostracods appeared early in August, and rapidly increased in number until the end of September, when they were literally swarming; the number then gradually decreased until March, 1922, when only four or five were present; another rapid increase followed, and the maximum number was reached by the end of May, 1922; in June the number decreased to about twenty specimens, and this has been an average number ever since. During the two and a half years, only females have appeared, and this supports the theory that the genus *Cypretta* is exclusively parthenogenetic. It is noteworthy that this sample of mud, which had been in a dry condition for seven years, only produced Ostracods.

Aquarium No. II.

Mud collected on Corona station, north of Broken Hill.

Species bred out: *Macrothrix spinosa* King, *Ceriodaphnia spinata* Henry, *Daph-*

nia carinata King, *Cypris lateraria* King, *Cypris bennelong* King, *Pachycyclops annulicornis* (Koch), *Boeckella coronaria* Henry.

Aquarium started November, 1921.

The first life to appear was three specimens of *Cypris lateraria*, which were mature by the end of January, 1922. On the 15th February, the first Cladoceran, *Macrothrix spinosa*, was noted, and on the 21st, two female *Boeckella coronaria*. By 30th March another species of Ostracod was identified as *Cypris bennelong*; at this date *Macrothrix spinosa* was the dominant species, and both male and female *Boeckella* were numerous. A single Cyclops was identified, on 3rd April, as *Pachycyclops annulicornis*, and this was the only Cyclops hatched in the aquarium. On 20th April, a specimen of *Ceriodaphnia spinata* was noted, and this species increased in numbers until it predominated; towards the end of the month several specimens of *Daphnia carinata* appeared. The numbers of *Ceriodaphnia* increased enormously, and on 14th June, the majority were bearing ephippia, and the other species were only represented by a few specimens; towards the end of the month there was a heavy mortality among the *Ceriodaphnia*, and by 1st September almost equal numbers of *Daphnia*, *Boeckella*, *Macrothrix*, and *Cypris* were present, and one or two *Ceriodaphnia*. *Daphnia* then rapidly increased in numbers and, by 21st September, they were very abundant, the females bearing ephippia, they also suffered a heavy mortality and, during October and November, Ostracods were the dominant feature. From December, 1922, to June, 1923, all forms were present, but none exceptionally numerous; then the Ostracods again increased and very few Cladocera and no Copepoda appeared until November, when all forms were again abundant. In February, 1924, Ostracods were alone present, but early in March *Boeckella*, *Macrothrix* and *Ceriodaphnia* had again appeared and the two latter were increasing in numbers.

Aquarium No. III.

Mud from Macumba, 35 miles north of Oodnadatta.

Species bred out: *Artemia salina* Linn.

Mud very fine, reddish in colour, containing smooth white pebbles.

Aquarium started 3rd April, 1922.

No life was seen until 24th September, when an immature Anostracan was noted. The specimen was identified on 5th October, when it appeared mature; on 9th October, it was seen to be bearing eggs; it died on 25th October, and no further life appeared.

Aquarium No. IV.

Mud collected at Bringagee.

Species bred out: *Macrothrix spinosa* King, *Moinodaphnia macleayii* (King), *Alona laevissima* Sars, *Cypris lateraria* King, *Boeckella minuta* Sars.

Aquarium started 19th April, 1922.

First appearance of life on 12th May, when several Ostracods were noted, and, from that date, Ostracods were always present in varying numbers. A single *Moinodaphnia* and two females of *Boeckella minuta* appeared on 15th May; *Macrothrix* and *Alona* were not present until September. For some months Ostracods largely predominated but in March, 1923, they were displaced by an immense number of *Macrothrix spinosa* which formed ephippia and, shortly afterwards, entirely disappeared. Ostracods have remained alone in the aquarium for the past year.

Aquarium No. V.

Mud from Meryula Station near Cobar.

Species bred out: *Leptocyclops agilis* (Koch), *Cypretta minna* (King), *Cypridopsis australis* Henry.

Aquarium started 14th June, 1922.

Within five days two minute *Leptocyclops* appeared; the first Ostracod was not noted until 1st September, but by November, the aquarium was swarming with both species of Ostracods. Shortly after this, the mud had an offensive smell and the aquarium was turned out.

Aquarium No. VI.

Mud from the same locality as V.

Species bred out: *Cypretta minna* (King), *Ceriodaphnia spinata* Henry, *Moina tenuicornis* Sars, *Cypridopsis australis* Henry.

Aquarium started 30th June, 1922.

The first Ostracod, *Cypretta minna,* appeared on 16th August, and by the end of the month there were many Ostracods of both species and a few specimens of *Ceriodaphnia.* The Ostracods rapidly increased in numbers and were very abundant early in October. In November, *Moina* predominated for a short time, the females became heavily laden with eggs, there was a heavy mortality, and by the end of the month not one remained. In March, 1923, there was a sudden increase of *Ceriodaphnia.* From April to June all forms were well represented, but after that date the Ostracods steadily increased and soon were the sole occupants of the aquarium.

Aquarium No. VII.

Mud from Buckanbe Station in the Darling River district.

Species bred out: *Cypretta minna* (King), *Candonocypris candonoides* (King), *Boeckella fluvialis* Henry.

Aquarium started 11th July, 1922.

Boeckella appeared first on 16th August, and then both Ostracod species towards the end of the month.

Boeckella fluvialis was moderately abundant at first, but none were seen after November. The Ostracods increased and were swarming in 1923, when the experiment had to be discontinued.

Aquarium No. VIII.

Mud from Kosciusko.

Species bred out: *Cypris reticulata* Zaddach, *Cypretta hirsuta* Henry.

Aquarium started 15th February, 1923.

Both species of Ostracods appeared early in March, but the mud, which contained a large amount of vegetable matter, smelt offensive and the aquarium was turned out.

Aquarium No. IX.

Mud collected near Brisbane, Queensland.

Species bred out: *Leptocyclops agilis* (Koch), *Ilyodromus viridulus* (Brady).

Aquarium started 2nd May, 1923.

A few specimens of *Leptocyclops* appeared early in June and were present in varying numbers until the end of August. No life was present from then until December, when the Ostracods appeared, and they have remained the sole occupants of the aquarium.

Aquarium No. X.

Mud from Central Australia, water hole on Boggy flat.

Species bred out: *Daphnia carinata* King var. *intermedia* Sars, *Cypris bennelong* King, *Cypretta globulus* Sars, *Cypridopsis australis* Henry.

Aquarium started 11th June, 1923.

Two species of Ostracod, *Cypris bennelong* and *Cypretta globulus*, appeared early in August, and were abundant by November. In December a few *Daphnia* appeared, and, in February, 1924, they were the predominant species; towards the end of February all the females carried ephippia and early in March they entirely disappeared. The Ostracods then rapidly increased, and all three species were present in great numbers.

Aquarium No. XI.

Mud from Federal water hole, Central Australia.

Species bred out: *Cypretta globulus* Sars.

Aquarium started 11th June, 1923.

First *Cypretta* appeared on 19th September, and this species became very numerous by the end of December, since then no life has appeared.

Aquarium No. XII.

Mud from Palm Creek, James Range, Central Australia.

Species bred out: *Cypris lateraria* King.

The mud consisted of loose scrapings containing leaves and dried *Estheria* shells.

Aquarium started 21st August, 1923.

Ostracods appeared early in September and rapidly increased, but the experiment had to be discontinued towards the end of October.

Aquarium No. XIII.

Mud collected at Nyngan.

Species bred out: *Dunhevedia crassa* King, *Cypris lateraria* King, *Cypris bennelong* King.

Aquarium started 27th September, 1923.

Both species of Ostracod appeared early in November, and quickly increased in numbers. *Dunhevedia crassa* was noted in February, 1924. Towards the end of March, all three species were plentiful, *Cypris bennelong* predominating.

Material from which Entomostraca were not obtained.

I. Dried scum from a pond near the sea, Chatham Island, New Zealand.
II. Surface material from Lake Eyre.
III. Mud from the Frome River entrance to Lake Eyre.
IV. Mud from Garah, near Mungindi, N.S.W.
V. Mud from clay pans on Boggy flat, Central Australia.
VI. Clay pans near Alice Well, Hugh River, Central Australia.
VII. Mud from a clay pan on Budda Station, near the Darling River.

THE NECTAR OF FLOWERS.

By Thos. Steel.

[Read 27th August, 1924.]

The first precise information regarding the amount of sugar contained in the nectaries of flowers with which I am acquainted, occurs in a paper by Alex. S. Wilson (Chem. News, 38, 1878, 93; Rep. Brit. Assn. Adv. Sc., 1878, Trans., 504, 564, 567; Jour. Chem. Soc., 34, 1878, 997; Pharm. Jour. Trans. [3], ix., 225). The weights of cane and fruit sugars found in individual blossoms or in heads of composite plants are stated, together with some very interesting speculations on the number of visits which a bee must make in order to collect a given weight of honey. From time to time references occur in literature to the abundance or otherwise of floral nectar. Roscoe and Schorlemmer (Treatise on Chemistry, iii., part ii., 498), after remarking that nectar contains cane sugar usually accompanied by fruit sugar, state that the cane sugar had even been found in crystals in *Rhododendron ponticum*. This latter statement I am unable to verify, as I have never met with such a case in the course of observations on numerous flowers, extending over many years. The above authors also state that Braconnot found 0.1 gram (100 mg.) sugar in a single flower of *Cactus Ackermanni*.

Maiden (Forest Flora, vii., part 4, 1920, 177) gives numerous references to nectar secretion in *Eucalyptus*, but no chemical data.

A. von Planta (Chem. News, 54, 1886, 237, quoted from *Comp. rendus*) reports the finding of 70.08 per cent. glucose and 1.31 cane sugar in the nectar of *Protea mellifera*, also 35.65 of cane sugar and 4.99 of glucose (stated glycerine in error) in that of *Hoya carnosa* and 14.84 glucose and 0.437 cane sugar in that of *Bignonia radicans*. The term glucose is now usually reserved for dextrose, particularly that prepared by the acid hydrolysis of starch.

Roth (Proc. Roy. Soc. Queensland, xvii., 1903, 49) mentions the sucking of nectar from *Banksia* flower cones by aborigines of Western Australia, and the preparation of a fermented drink "*mangaitch*" from water impregnated with the cones.

Carne (Aust. Naturalist, ii., 1913, 198) describes observations on the secretion of nectar by extra-floral nectaries in *Acacia*, and remarks on the uselessness of these glands for fertilization purposes by insects, when, as is frequently the case, they are situated at a distance from the flowers. He suggests that the attraction of insects by the nectar and consequent cross fertilization of the plant is a secondary, and not the original cause of nectar secretion.

As is to be expected there is extreme variation in the quantity of nectar contained in different flowers. Apart from the difference in size of blossoms and

their consequent capacity, some large flowers contain but little, while other comparatively small blossoms contain a relatively large amount. My general observation is that plants visited by nectar-feeding birds have large supplies, whilst those frequented by insects find a smaller supply adequate.

Again, the amount of nectar found in flowers will depend to an uncertain extent on how far they have been rifled by birds or insects.

There is another factor controlling the amount of nectar, the use by the plant itself of the secreted material. Prolonged observation has convinced me that unless removed by insects or birds, the nectar is soon absorbed by the plant, probably going to nourish the growing ovary. This may be the use of the secretion produced by the extra-floral nectaries noted by Carne (*loc. cit.*), and perhaps was the original purpose of nectar secretion in general. In such case profound changes in the structure of the floral organs and of their insect visitors, would be gradually brought about through mutual adaptation. The sweet secretion would thus form a convenient food supply for the use of the plant, analagous to that laid up by many plants in the form of sugar, starch, inulin, etc. The method of observation followed by me was to protect the blossom by tying a paper bag over it, using a collar of cotton wool to exclude ants. The disappearance of the nectar in the course of a day or two, could thus be readily demonstrated.

From time to time I have examined flowers for the sugar contents of the nectar and the results may conveniently be stated here along with those obtained by Wilson (*loc. cit.*) for comparison.

The method of examination followed was to wash out with water a definite number of blossoms to a known volume and determine the copper reducing power before and after inversion with hydrochloric acid, the surplus reducing power after inversion being calculated to cane sugar. The absence of starch, which would yield reducing sugar on treatment with hydrochloric acid, was demonstrated.

Sugar in flowers. A. S. Wilson. (Chem. News, 38, 1878, 93).

	Milligrammes.		
	Cane sugar.	Fruit sugar.	Total.
1. Fuchsia. per flower	5.61	1.69	7.30
2. *Claytonia alsinoides.* per flower	0.23	0.18	0.41
3. Everlasting pea. per flower	1.52	8.33	9.85
4. Vetch. *Vicia cracca.* per raceme	0.01	3.15	3.16
5. Vetch. *Vicia cracca.* per single flower	—	0.16	0.16
6. Red clover. per head	1.89	5.95	7.84
7. Red clover. per floret	0.03	0.10	0.13
8. Monkshood. per flower	1.69	4.63	6.32

Wilson shows cane sugar in its fruit sugar equivalence. I have calculated it back to cane sugar, so as to permit of comparison with other results.

Sugar in flowers. T. Steel.

		Mg. per flower.			
		Cane Sugar.	Fruit Sugar.	Total.	Total % on flower.
1. *Leonotis leonurus*	23.1.85	4.00	3.90	7.90	5.4
2. " "	4.2.85	2.90	4.50	7.40	4.8
3. " "	10.2.85	3.10	3.00	6.10	4.7
4. *Vitex litoralis*	9.2.85	1.20	7.30	8.50	2.4
5. *Metrosideros tomentosa*	26.1.85	1.60	—	—	—

6. *Lambertia formosa*	7.6.97	2.10	7.50	9.60	7.7
7. *Grevillea robusta*	—	0.50	0.17	0.67	0.1

The last column shows % total sugar on weight of flower. *L. leonurus*, a South African shrub, cultivated in gardens, Auckland, New Zealand. *V. litoralis*, the N.Z. Puriri, Auckland. *M. tomentosa*, N.Z. Christmas tree, Auckland. *L. formosa* and *G. robusta*, Australian plants, near Sydney. The corolla tubes of *Lambertia* are commonly found to be split, evidently by birds.

It will be seen that my figures are of the same order as those of Wilson.

It has long been obvious to me that there is a great difference in the concentration of nectar as it occurs in flowers and of honey as stored in the comb by bees. The nectar can readily be shaken out of most flowers, which could not be done were it as dense as honey. It thus becomes evident that the bee concentrates the nectar by abstraction of water, probably while it is in the honey sac. At this time also the bee secretes an enzyme which causes gradual inversion of most of the cane sugar present. In order to investigate this matter of increase in density, I have examined a number of nectars. Through the courtesy of the Government Botanist and with the assistance of Mr. W. F. Blakely and Mr. E. N. Ward, I was enabled to secure flowers from the Botanic Gardens, Sydney, and by the kindness of Dr. Tom Guthrie was able to examine these in the laboratory of the Colonial Sugar Refining Co., Ltd. The examination was carried out by means of the very fine Abbé refractometers belonging to the laboratory and with the help of Dr. Guthrie's skilled assistants. To all these gentlemen I record my gratitude.

For an accurate determination of density a few drops of nectar are all that is required, and from the refractive index so obtained, the sugar and water can be ascertained with a high degree of refinement. Using a slender glass pipette it was easy to withdraw sufficient nectar from most blossoms, to permit of examination, while with others the nectar could be squeezed or dropped direct onto the glass observation wedge of the instrument. The results obtained are detailed below. I have added a column showing the percentage weight of water to be removed in order to bring the nectar to the same degree of concentration as honey of 21.54% water. This shows the amount of removal of water effected by the bee, and it is seen to be a very considerable proportion of the weight of the nectar, ranging from 88.5% in the weakest to 47.8% in the most concentrated nectar examined.

	Date.	Refractive index.	% Sugar.	% Water.	% Water to be removed.
1. *Barringtonia alba*	21.12.23	1.3455	9.05	90.95	88.5
2. *Quisqualis indica*	4.1. 24	1.3477	10.45	89.55	86.7
3. *Eucalyptus alophylla*	21.12.23	1.3505	12.30	87.70	84.3
" "	28.12.23	1.3529	13.95	86.05	82.2
" "	4.1. 24	1.3484	11.00	89.00	86.0
4. *Crinum latifolium*	13.11.23	1.3551	15.30	84.70	80.5
5. *Bouvardia triphylla*	21.12.23	1.3559	15.75	84.25	79.9
6. *Metrosideros tomentosa* . . .	21.12.23	1.3568	16.35	83.65	79.2
7. *Erythrina Christi-galli* . . .	21.12.23	1.3636	20.50	79.50	73.9
" " " . . .	28.12.23	1.3611	19.00	81.00	75.8
8. *Pterospermum acerifolium* .	17.11.23	1.3654	21.65	78.35	72.4
9. *Jacobina magnifica*	4.1. 24	1.3659	21.85	78.15	72.2
" "	28.12.23	1.3735	26.40	73.60	66.4
10. *Gerbera Tanghin*	11.12.23	1.3661	22.00	78.00	72.0

11. *Campis grandiflora*	13.11.23	1.3676	22.90	77.10	70.8
" "	11.12.23	1.3675	22.80	77.20	71.0
" "	4.1. 24	1.3692	23.80	76.20	69.7
12. *Stenolobium stans*	4.1. 24	1.3695	24.00	76.00	69.4
13. *Grevillea Banksia*	11.12.23	1.3697	24.10	75.90	69.3
14. *Castanospermum australe*	4.1. 24	1.3708	24.75	75.25	68.5
15. *Juanulloa aurantica*	11.12.23	1.3862	33.45	66.55	57.4
16. *Alpinia nutans*	4.1. 24	1.4007	41.20	58.80	47.8

The following are the countries of origin of the plants enumerated:—

N.S. Wales 14, Queensland 13, W. Australia 3, New Zealand 6, N. America 11, 12, Brazil 7, 9, Mexico, 5, 15, E. India 2, 4, 8, 16, Madagascar 10, Molucca 1.

The figures for samples of nectar from the same plant, taken on different occasions, disclose a very fair uniformity in density, and it seems probable that each plant has its critical density, which is maintained by osmotic action between the nectary and the surrounding tissues, and any evaporation thus compensated.

The small amounts of ash, and organic matter other than sugar, present in the nectar are insufficient to make any notable difference in the figures.

In no case does the concentration of the nectar remotely approach a point at which it would be possible for sugar to crystallize out.

Acting on a suggestion of Mr. Blakely, I have arranged the plants examined, in families, in the order of concentration of nectar, with the following results.

Family	Average per cent. sugar in nectar.	
Zingiberaceae	41.2	Very sweet
Solanaceae	33.4	
Acanthaceae	24.1	Sweet
Proteaceae	24.1	
Bignoniaceae	23.6	
Leguminosae	22.2	
Apocynaceae	22.0	
Sterculiaceae	21.7	
Rubiaceae	15.8	Medium
Amaryllidaceae	15.3	
Myrtaceae	11.6	Poor
Combretiaceae	10.5	

Classified in this way the families arrange themselves into four groups which I have termed as above. A considerably greater number of observations, embracing other families, would be required in order to arrive at a generalization.

Little has been published regarding the composition of separated nectar, it being in most cases difficult or impracticable to get sufficient material for a detailed analysis. On two occasions Mr. A. G. Hamilton supplied me with flower spikes of *Doryanthes excelsa* collected in the South Coast district of N.S. Wales. *D. excelsa* is a large amaryllid plant, bearing a tall spear-like flower-stem crowned with a bulky panicle of red flowers in which abundance of nectar is secreted. From these I was able to extract sufficient for analysis. For comparison I have inserted an analysis of a sample of pure honey, given to me by the late Mr. Albert Gale, apiarist to the N.S. Wales Department of Agriculture, and have

calculated the *Doryanthes* nectars to the same degree of concentration as the honey. The granulation of ordinary honey is due to the separation of dextrose in crystals.

	Nectar of *Doryanthes*. Natural State		Calculated.		
	a.	*b.*	*a.*	*b.*	Pure Honey
Date.	1.11.99	27.6.01	1.11.99	27.6.01	June, 1898.
Cane Sugar	Nil.	Nil.	Nil.	Nil.	2.70
Dextrose	4.52	3.68	39.80	41.78	37.80
Levulose	4.10	2.97	36.11	33.74	37.00
Other Organic Matter .	0.15	0.13	1.32	1.47	0.89
Ash	0.14	0.13	1.23	1.47	0.07
Water	91.09	93.09	21.54	21.54	21.54
	100.00	100.00	100.00	100.00	100.00

Dextrose and levulose together, constitute fruit sugar. The Doryanthes nectar contained no cane sugar. At equal densities there is a remarkably close resemblance in composition between it and honey. In degree of concentration the nectar is a thin one, in this respect being much like that of *Barringtonia alba.* In examining the nectar of *Doryanthes* it was noticed that the admixed pollen grains had sent out extremely long pollen tubes, very interesting under the microscope.

NOTES ON AUSTRALIAN DIPTERA. No. iii.

By J. R. Malloch.

(*Communicated by Dr. E. W. Ferguson*).

(Four Text-figures).

[Read 30th July, 1924.]

Because of the paucity of material available at this time, the notes presented in this paper are printed merely as a guide to the forms before me, and in the hope that they may prove an incentive to the collector and student of Diptera to take more interest in this much neglected group. Should the publication of this paper result in accessions of material sufficient to justify such a course, it is my intention to present later generic and specific keys for the identification of the known Australian forms whenever a fairly representative series has been studied.

The great majority of the specimens have been sent to me by Dr. Eustace W. Ferguson, but a few have been obtained from Dr. C. F. Baker, Los Banos, Philippine Islands.

Family CHLOROPIDAE.

I have, in another paper, listed the characters for the recognition of this family, and described three species of the genus *Parahippelates* Becker. Since the completion of that paper, I have obtained from Dr. Ferguson a series of specimens of this genus, amongst which are several that are new. Some of these are described herein, and some records are presented of other species, but it is highly probable that an intensive effort to obtain material will result in considerable accessions to the list, as the genus is essentially Australasian, being known only from Australia and New Guinea.

Parahippelates costomaculata, n.sp.

Male.—Head yellow, upper occiput and frontal triangle fuscous, the latter shining, face and cheeks almost white, the latter browned below middle of eye; third antennal segment brown at insertion of arista; arista and its hairs fuscous; palpi and proboscis yellow. Thorax and abdomen black, slightly shining, and with thin greyish pruinescence. Legs entirely yellow. Wings hyaline, with a large black spot on costa from a little beyond apex of first vein to just beyond apex of second and extending on disc to third vein. Halteres whitish.

Frons as in the other species of the genus; face almost flat; cheek about as high as width of third antennal segment, and one-fourth as high as eye; vibrissal angle with two bristles; aristal hairs about as long as basal diameter of arista.

Thoracic chaetotaxy as in *brunneicosta* Malloch. Hind tibial spur about as long as tibial diameter. Section of costa in front of apex of second vein as compared with the one beyond it as 7:5; veins 3 and 4 parallel, last section of latter about three times as long as preceding section; outer cross-vein at fully twice its own length from apex of fifth. Length, 2 mm.

Type and paratype, Sydney, N.S.W., 31 Dec., 1922.

PARAHIPPELATES ALBISETA, n.sp.

Male and female.—Head pale yellow, darker on occiput and upper half of frons; ocellar spot, second antennal segment, and entire proboscis black; third antennal segment brownish above; arista brown at base, the remainder and its hairs white. Thorax tawny yellow, brownish in places, with whitish pruinescence, most distinct on middle of dorsum when seen from behind, the lateral margins of mesonotum and some patches on pleurae blackish, a central vitta of brownish colour on mesonotum more or less distinct. Abdomen fuscous, apices of the tergites yellowish; male hypopygium tawny yellow. Legs pitchy brown, trochanters and basal three segments of all tarsi yellowish. Wings greyish hyaline, veins blackish. Halteres fuscous or dark brown.

Head much as in *brunneicosta* Malloch, but the arista differently coloured, and the hairs more dense, the longest distinctly longer than its basal diameter; the vibrissal angle is slightly produced and the cheek at middle is fully one-third of the eye-height. Thorax as in *brunneicosta;* scutellum flattened on disc, with two discal hairs, the basal pair of bristles noticeably shorter than the apical pair. Hypopygium of male knob-like. Legs normal, apical spur of hind tibia curved, as long as tibial diameter. Last section of fourth vein fully as long as preceding section; outer cross-vein at about 1.75 its own length from apex of fifth. Length, 3-3.5 mm.

Type, male, allotype, 4 male and 1 female paratypes, Eidsvold, Queensland.

PARAHIPPELATES FUSCIPES, n.sp.

Male and female.—Head yellow, frons brownish, paler in front, triangle brown, grey pruinescent; cheeks and face whitish pruinescent, upper occiput fuscous, yellowish in middle behind ocelli; antennae yellow, brownish on upper side of third segment; arista brown at base, yellowish beyond; palpi yellow; proboscis black. Thorax black, dorsum shining, brownish-grey pruinescent, with a slight olive tinge and more or less distinctly trivittate with fuscous; propleura yellowish, the spiracle noticeably so; apex of scutellum slightly darkened. Abdomen rufous-brown, usually with the bases of the tergites darker; hypopygium of male tawny yellow. Legs tawny, all femora and usually the hind tibiae broadly fuscous; apical two tarsal segments fuscous. Wings greyish hyaline, veins very conspicuous. Halteres pale yellow.

Head as in *nudiseta* Becker, the arista with its longest hairs not as long as its basal diameter; cheek nearly two-thirds of the eye-height. Thorax as in *nudiseta*, but the scutellum more convex on disc. Outer cross-vein at about its own length from apex of fifth vein; wing broader than in *nudiseta*. Length, 4-5 mm.

Type, male, allotype, two male and two female paratypes, Sydney; two paratypes, Milson Is., Hawkesbury River. One female from Sydney has the femora, except a small part of the fore pair, yellow.

PARAHIPPELATES NUDISETA Becker.

I quoted the description of this species in the paper already referred to on this genus. It agrees very closely with *fuscipes,* but the legs are entirely yellow, with the exception of the apical two tarsal segments, the scutellum is not dark at apex, the wings are yellowish hyaline, the outer cross-vein is at much more than its own length from apex of fifth, and the size is less. Length, 3-4 mm.

Two specimens, National Park, Sydney, 28 October, 1922. Originally described from Botany Bay; type in Hungarian National Museum, Budapest.

PARAHIPPELATES AEQUALIS Becker.

Very similar to *nudiseta* in colour, but the wings are greyish hyaline, the cheek is about half as high as the eye, the arista has its longest hairs distinctly longer than its basal diameter, and the outer cross-vein is distinctly more than its own length from apex of fifth. Length, 3-4 mm.

One specimen, Sydney, and one Coramba-Dorrigo Rd., N.S.W.

Originally described from New Guinea; type in same collection as that of *nudiseta.*

Genus EPHYDROSCINIS novum.

Generic characters.—Belongs to the subfamily Oscininae, the costa extending to apex of fourth vein, and the hind tibia having a long narrow sensory area at middle on its postero-dorsal surface which is covered with microscopic hairs. The male may be distinguished from that of any other genus by the peculiar geniculated arista (Fig. 1), but in the female the arista is of the usual type in this family. In both sexes there are two long bristles on each humeral angle, as in *Parahippelates,* one incurved, the other outwardly directed or sloping backwards; the sternopleura has a weak upper setula and fine pale discal hairs; scutellum normal; thorax with about three pairs of dorsocentrals; head as in *Parahippelates.* Legs normal, hind tibia without an apical spur; wings as in *Parahippelates.*

Genotype, the following species.

EPHYDROSCINIS AUSTRALIS, n.sp.

Male and female.—Black, opaque, with dense pale grey pruinescence. Frons dark brown, yellow on anterior margin, grey on sides of triangle; face and cheeks yellowish, densely whitish pruinescent; antennae fuscous, third segment orange-yellow, except on upper margin; arista pale brown; palpi yellow, proboscis and inner mouth-margin black. Thorax with the disc largely fuscous, showing traces of darker vittae, with the lateral margins yellow-grey pruinescent, and the bases of the bristles set in grey pruinose spots; pleura grey; scutellum black on disc, grey on margins. Abdomen with the dorsum blackish-brown, hind margins of the tergites pale grey, a pair of grey spots on hind margin of first visible tergite. Legs fuscous, trochanters, apices of femora, bases and apices of tibiae, and basal two or three tarsal segments tawny yellow. Wings hyaline, veins black. Halteres whitish.

Vertical, post-ocellar, and ocellar bristles distinct, each orbit with about three distinct setulae; interfrontalia setulose; triangle extending almost three-fourths of the way to anterior margin; face slightly concave, vertical; cheek at middle about half as high as eye; two bristles on each anterior angle in male, one above the other, only one in female; arista of male and female as in Figure

1; eyes bare. Acrostichals very short; scutellum with four bristles. Apical three segments of mid tarsi broadened. Second division of costa about 1.25 as long as third; first posterior cell very slightly narrowed apically; outer cross-vein at a little over its own length from apex of fifth; last section of fourth vein fully twice as long as preceding section. Length, 3 mm.

Type, male, and allotype, Woy Woy, 2 September, 1923 (Mackerras).

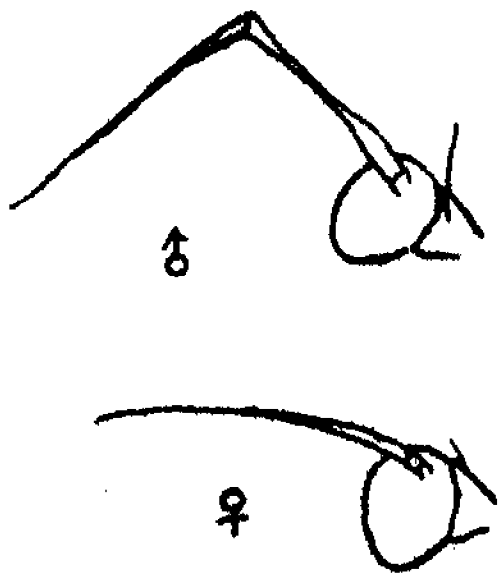


Fig. 1.—Antennae of *Ephydroscinis australis*.

Genus CHLOROMERIS Becker.

This genus belongs to the subfamily Chloropinae, the costa extending only to the apex of third vein, and the hind tibiae being simple, without a sensory area above. From other genera in the subfamily, it may be readily distinguished by the very thick hind femora which are furnished with minute black spines on apical half below.

There are two known species, both from Australia, which may be distinguished as below.

Pleura with five black spots, one on each of the following parts: mesopleura, propleura, pteropleura, sternopleura, and hypopleura; upper inner mouth-margin black; mesonotum with five shining black vittae .. .. *purus* Becker.

Pleura with three black spots, those on pteropleura and propleura absent; mouth-opening entirely yellow; mesonotum with three shining black vittae, the lateral pair fused .. .. *pallidior* Becker.

I have seen only *pallidior*. One specimen labelled North Harbour, March 30, 1923. This species was originally described from Queensland, the other from New South Wales. I now designate *purus* as the genotype. Types are in the Hungarian National Museum.

Genus CHLOROPSINA Becker.

Becker erected this genus for the reception of two small species from New Guinea. He distinguished it from *Chlorops* by the unicoloured black thorax and scutellum, the head being wider than the thorax, and the short second costal division of the wing. The eyes are stated to be very large, covering almost the entire side of the head, and the scutellum is convex. In other respects as *Chlorops*.

I have before me a specimen which runs to this genus in Becker's key, but the eyes do not cover more of the side of the head than is usual in *Chlorops*, the scutellum is flattened above, and the second costal division is a little longer than the third. I was inclined to consider the species as referable to *Chlorops*,

but it differs from typical members of that genus in having the vertical and ocellar setulae almost indistinguishable, the frontal triangle long and glossy, and the prescutellar bristles indistinct.

CHLOROPSINA NIGROHALTERATA, n.sp.

Female.—Glossy black. Frons anteriorly, face, cheeks, and antennae rufous, third antennal segment dark above, arista brown; palpi and upper mouth-margin brown. Humeri and pleura anteriorly brownish-red. Legs black, bases of fore tibiae and basal two or three segments of all tarsi rufous-yellow. Wings clear. Halteres blackish.

Head very little wider than anterior margin of thorax, frons fully half the head width, triangle glossy, not entirely filling vertex, its sides almost straight, the apex almost filling width of space between bases of antennae; the latter of average size, third segment round; arista sub-nude; frons protruded beyond eye about one-third of the length of latter; face concave in profile; cheek about as high as width of third antennal segment. Thoracic dorsum not punctate, with rather dense, short, decumbent, fuscous hairs; scutellum flattened on disc and haired as disc of thorax, with two short apical bristles. Abdomen broad, rather abruptly pointed at apex. Legs normal. First and second sections of costa sub-equal, either a little longer than third; fourth vein curved upward beyond outer cross-vein, then deflected at apex; third vein ending a little in front of apex of wing; inner cross-vein well in front of apex of first vein. Length, 3.25 mm.

Type, Milson Id., 20 November, 1914. Distinguished by the black halteres.

Family EPHYDRIDAE.

Subfamily CANACEINAE.

The usual definitions of this family contain a statement, to the effect that the costal vein is twice broken, once just beyond the humeral vein, where the break is not very obvious, consisting of a weakened part of the vein instead of a distinct break, and again in front of the apex of first vein. The anal cell is normally absent. In Canaceinae, however, there is no appreciable break or weakening of the vein just beyond the humeral vein and the break at apex of the first vein is small, while the anal cell is quite distinct. In some respects, e.g., the bristling of the frons, there is a resemblance to the genus *Ephydra*, and this is strengthened by the shape of the head, though in Canaceinae the labrum is exposed in an emargination of the lower margin of the mouth, which is not the case in *Ephydra*. In the latter there are distinct spiracles in the tergites some distance from their inner margins, while in Canaceinae there are none.

There are some characters in Canaceinae which are found in Tethinae, but probably the group is more appropriately placed in Ephydridae than in Agromyzidae. A definite decision on its true affinities must await a knowledge of the immature stages.

Hendel is responsible for breaking the old genus *Canace* Haliday into four genera which may be identified by means of the following key.

Key to genera.

1. Frontal triangle extending to about middle of frons, its apex prolonged slightly; pleura bare; dorsocentral bristles in four pairs. *Procanace* Hendel.
   Frontal triangle extending to anterior margin of frons . . . . 2.
2. Cheeks and pleura bare; scutellum with two bristles; dorsocentrals in four pairs . . . . *Chaetocanace* Hendel.

Cheeks and pleura with setulae or bristles; scutellum with more than two bristles .. .. 3.

3. Mesonotum with four pairs of dorsocentral bristles, the anterior pair in front of suture .. .. *Canace* Haliday.

Mesonotum with two pairs of dorsocentrals, both behind suture. .. .. *Xanthocanace* Hendel.

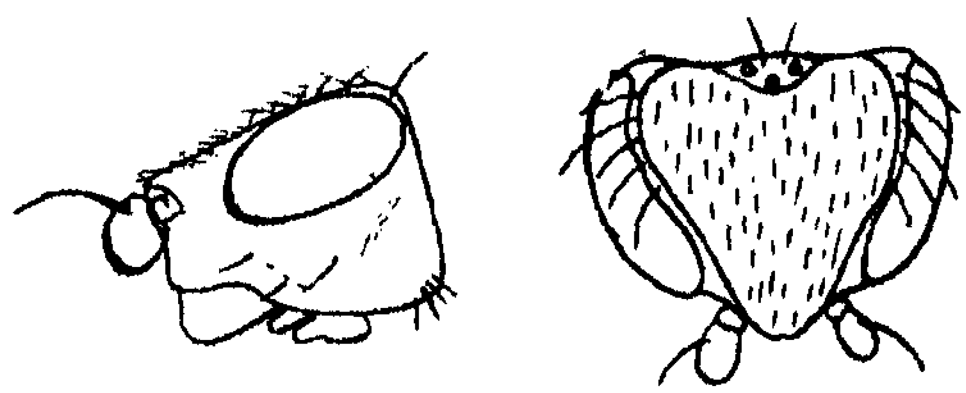
Genus XANTHOCANACE Hendel.

In this genus there are, so far as I can discover from the literature, only three species, *ranula* Loew, *orientalis* Hendel, and *magna* Hendel, the first being the genotype.

I have before me a male specimen which does not agree very well in wing characters with the generic diagnosis given by Hendel, but I consider it better to stress a point in relegating it to this genus, rather than to add another genus to a group already more than sufficiently subdivided. The difference in wing venation lies in the almost straight fourth vein on its apical two sections, whereas Hendel states that in his three included species, the "Vierte Langsader jenseits der hintern Querader mehr oder weniger stark aufgebogen."

XANTHOCANACE NIGRIFRONS, n.sp.

Male.—Black, densely pale grey pruinescent, more white on the head, the frontal triangle almost glossy black; dorsum of thorax brown on disc; scutellum



2. 3.

Figs. 2, 3.—*Xanthocanace nigrifrons*. 2. Head from side; 3. Head from above.

faintly so; abdomen with a faint brownish tinge basally on dorsum. Antennae and arista black, apex of proboscis and the entire palpi yellow. All hairs and bristles yellowish. Wings hyaline, veins brown, yellow at bases. Legs yellow, coxae and femora, except apices, greyish fuscous. Halteres lemon-yellow.

Head in profile as in Figure 2, dorsum as in Figure 3; arista bare. Dorsum of thorax with four series of intradorsocentral hairs; propleural bristle absent; no strong bristles, only hairs, on meso- and sternopleura; disc of scutellum with numerous long hairs which are about as long as the four fine marginal bristles. Abdomen tapered apically, genital segment rufous below. Legs slender, fore femur without strong ventral bristles; tarsi slightly widened apically. Inner cross-vein a little before middle of discal cell; last section of fourth vein parallel with third, slightly arcuate; outer cross-vein at nearly its own length from apex of fifth vein. Length, 2.5 mm.

Type, Woy Woy, 2 September, 1923 (Mackerras).

Subfamily EPHYDRINAE.

Genus BRACHYDEUTRA Loew.

This genus is distinguished from its allies by the short second wing-vein which connects with the costa about as far from apex of first vein as the latter is from

the humeral vein, the third costal section nearly three times as long as second; fourth vein evanescent beyond the outer cross-vein; costa ending at apex of third vein and almost exactly in wing tip. Frons with a pair of bristles in front of ocelli that are as long as the ocellar pair; arista long haired above; genal bristle absent; sides of face with a few setulae or hairs, centre with a blunt carina; mesopleura and sternopleura with some fine hairs or setulae; mid tibia without median bristles. The abdominal spiracles are situated on the tergites some distance from their lateral margins.

There are two species already known, one, *argentata* Walker, occurring in North America and Northern Africa, and the other, *longipes* Hendel, in Formosa.

BRACHYDEUTRA SYDNEYENSIS, n.sp.

Male and female.—Black, densely silvery grey pruinescent below and on sides, largely opaque brown above. Antennae black; facial keel brown; palpi yellow; hairs on sides of face white. Thoracic dorsum with five dark-brown vittae anteriorly, the median one replaced by a paler stripe behind suture; disc of scutellum brown, greyish at base in middle; upper margin of pleura brownish. Anterior and posterior margins of abdominal tergites and a central line dark brown on a greyish ground. Legs tawny yellow, femora usually darker in middle, apices of tibiae and of tarsi dark brown. Wings hyaline. Halteres yellow.

Facial keel not sharper than in *argentata;* arista with about 12 rays. Last section of fourth vein very little longer than preceding section. Length, 3.5 mm.

Type, male, and one male paratype, Collaroy; allotype and 4 paratypes, Belaringar.

In addition to the foregoing, I have before me species belonging to the genera *Paralimna* Loew and *Notiphila* Fallen, but await the accession of more material before writing up the species.

Family AGROMYZIDAE.

The members of this family are distinguished by the presence of the anal cell of the wing, the rudimentary mediastinal vein, which is either fused with first some distance from its apex or indistinct on apical third. The great majority of the genera have distinct vibrissae, the post-vertical bristles divergent or parallel, no distinct pre-apical tibial bristle, either the mesopleura or sternopleura or both with distinct bristles, and the thorax with at least one distinct pair of pre-scutellar dorsocentral bristles. Many species in the genus *Agromyza* have a pair of posterior setulae on mid tibia.

I have representatives of four subfamilies of this group from Australia.

Subfamily MILICHIINAE.

All the genera of this subfamily have the frons with two series of fine hairs or setulae on the interfrontalia, and the postvertical bristles not divergent.

I give below a key to the three genera which I have from Australia.

Key to genera.

1. An angular incision at middle of hind margin of eye; wing with a very deep incision at apex of first vein .. .. *Milichiella* Giglio-Tos.
   Eye entire on hind margin, not incised; costa broken but not deeply incised at apex of first vein .. .. 2.

2. Pteropleura bare; interfrontalia with the series of hairs on differentiated stripes which are usually more or less pruinescent .. *Desmometopa* Loew.
 Pteropleura with some setulose hairs; interfrontalia with the setulose stripes not differentiated from rest of surface ..... *Hypaspistomyia* Hendel. (*Prodesmometopa* Hendel.)

Genus MILICHIELLA Giglio-Tos.

MILICHIELLA LACTEIPENNIS Loew.

A glossy-black species with whitish wings and entirely black legs. Very widely distributed, occurring in Java, North, Central, and South America, Hawaii, Canary Islands, New Guinea and Australia.

Four specimens, Eidsvold, Queensland.

Genus DESMOMETOPA Loew.

DESMOMETOPA CILIATA Hendel.

This species was described from Sydney by Hendel. I have one specimen that agrees with his description very closely, and three that appear to be inseparable from *m-nigrum* Meigen. I suspect that the Australian specimens may really be the latter, as the only structural character separating *ciliata* from that species consists of the longer hairs proximad of the apex of first vein in *ciliata*, and in only one of my specimens is this noticeable, the others having the hairs short as in North American specimens of *m-nigrum*.

Locality, Sydney. I have another species of the genus from South Australia, but defer naming it.

Genus HYPASPISTOMYIA Hendel.

This genus is represented in the material before me by one species, which I believe is undescribed. The genotype occurs in Arabia, one species occurs in Europe and North America, one in North America, and one in the East Indies.

HYPASPISTOMYIA ALBIPENNIS, n.sp.

Male.—Black. Frons opaque, triangle and upper half of orbits glossy, anterior half of orbits silvery white; cheeks silvery; palpi and proboscis fuscous. Mesonotum with thin white pruinescence on sides, shining over all, dorsum of scutellum slightly bronzy. Abdomen subopaque fuscous, apical two segments and sides glossy black. Legs black, mid and hind metatarsi yellowish at bases. Wings and knobs of halteres white.

Post-vertical bristles convergent; upper two pairs of orbitals outwardly directed, anterior two pairs incurved; orbits linear; ocellar bristles short; antennae small, arista not longer than anterior width of frons; cheek at highest point over one-third of eye-height; proboscis slender, geniculated; palpi dilated. Thorax with one long and one very short pair of pre-scutellar dorsocentrals; basal scutellar bristles short. Hind tibia very much broadened. Wings as in *latipes* Meigen. Length, 1.5 mm.

Type and one paratype, Belaringar, 9 September, 1923.

Subfamily TETHINAE.

Thoracic chaetotaxy and wing venation similar to Agromyzinae. The frons, however, has the orbital bristles directed outward over eye, and though there is a small pair of divergent bristles behind the ocelli, what appear to be the true

postvertical bristles are convergent or subparallel and rather widely placed, either on the extreme hind margin of frons or slightly below it.

The other subfamilies have the anterior orbital bristles, when present, incurved or erect, never curved over eye.

There are several genera of the subfamily, but so far I have seen only one specimen from Australia. It does not agree with the description of any species known to me so I describe it as new.

TETHINA NIGRISETA, n.sp.

Male.—Head yellow, cheeks whitish pruinescent, occiput grey except on lower margin. Thorax black, densely grey pruinescent. Abdomen luteous, first tergite greyish in middle, the other broadly grey basally. Legs yellow, apical tarsal segment fuscous. Wings hyaline. Halteres whitish yellow.

Each orbit with four bristles; interfrontalia with two or three cruciate pairs; post-ocellar bristles pronounced; cheek at highest point about one-fourth of the eye height; arista yellow, microscopically pubescent, not much longer than antennae; eye a little higher than long; frontal bristles black, those on cheeks

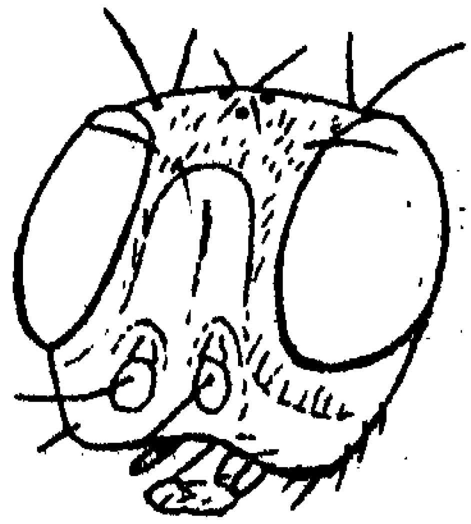


Fig. 4.—*Fergusonina microcera.* Head from the side and in front.

yellow. Thorax with four series of setulae between the four pairs of strong dorsocentrals; basal pair of scutellar bristles about half as long as apical pair; all thoracic hairs and bristles black. Abdominal hairs black. Strong bristles and hairs on legs black, the fine hairs yellow. Inner cross-vein very little proximad of middle of discal cell, the section of fourth vein between the cross-veins subequal in length to apical section of fifth, and a little less than half as long as apical section of fourth. Length, 1.75 mm.

Type, Woolgoolga, N.S.W., 27 January, 1923.

Subfamily AGROMYZINAE.

I have a number of representatives of the Agromyzinae from Australia, but it is very probable that many more will be forthcoming, so I defer dealing with those belonging to *Agromyza* and *Phytomyza* until later.

Genus FERGUSONINA, novum.

Generic characters.—Antennae inserted close to lower margin of eye in profile; head as in Figure 4, the antennae small and in distinct pits. Thorax as in *Agromyza*, the mesopleura and sternopleura bristled. Female with a chitinous tube-like ovipositor. Fore femur with rather long postero-ventral bristles. Costal vein ending a little beyond apex of second vein, third vein distinct, ending in

apex of wing, fourth and fifth veins less distinct on apical portions than third, outer cross-vein evanescent or absent.

Genotype, the following species.

FERGUSONINA MICROCERA, n.sp.

Female.—Yellow, narrow rings surrounding ocelli, and the arista black. Dorsum of basal four visible abdominal tergites fuscous, ovipositor glossy black. Wings hyaline.

Ocellar and post-vertical bristles equal; each orbit with one bristle; arista subnude; mouth-parts small. Mesonotum with two pairs of dorsocentrals and one pair of acrostichals on hind margin; scutellum with four bristles, basal pair short. Legs strong, tarsi stout. Inner cross-vein below apex of first vein and nearly two-thirds from base of discal cell, last section of fourth vein over four times as long as preceding section. Length, 1.5 mm.

Type, North Harbour, 30 March, 1923.

Named in honour of Dr. E. W. Ferguson.

Family ASTEIIDAE.

Related to Drosophilidae, as a subfamily of which it is sometimes placed. Frons without forwardly-directed orbital bristles, the vibrissae short or almost invisible, costal vein weakened, but not broken, at apex of first vein, first posterior cell of wing distinctly narrowed at apex.

There is one specimen before me which appears to be undescribed.

Genus LEIOMYZA Macquart.

This genus differs from its allies in having the outer cross-vein of wing present, the second vein not abnormally shortened, the second costal division being two or three times as long as first, and the arista bare or pubescent. There are the following bristles on the thorax: dorsocentrals, 1 pair; scutellars, 1 strong pair; notopleurals, 1. I can detect no sternopleural bristle on this species, though other species have one.

LEIOMYZA NITIDULA, n.sp.

Female.—Frons glossy brown, ocellar triangle black; face, cheeks, and antennae brown, upper half of third antennal segment and the lower margin of cheek blackish; occiput black; palpi yellow. Thorax and abdomen glossy black. Legs yellow, basal half of all femora black, apical segment of all tarsi brown. Wings hyaline, veins brown. Halteres pale yellow.

Frontal triangle extending three-fourths of the way to anterior margin; orbits with two or three short hairs, but no distinct bristle; ocellar and post-vertical bristles microscopic; face concave in profile, the parafacial invisible from side. Thoracic dorsum with short sparse black hairs, the dorsocentral bristles well in front of posterior margin; a fine hair in front of each scutellar bristle. Abdominal hairs very sparse and short. Legs slender. Second costal division fully three times as long as first and about 1.5 as long as third; inner cross-vein a little before middle of discal cell and below apex of first vein. Length, 2 mm.

Type, Sydney 15 July, 1923.

AN AUSTRALIAN CARYOPHYLLAEID CESTODE.

By Professor T. Harvey Johnston, University of Adelaide.

(Seventeen Text-figures).

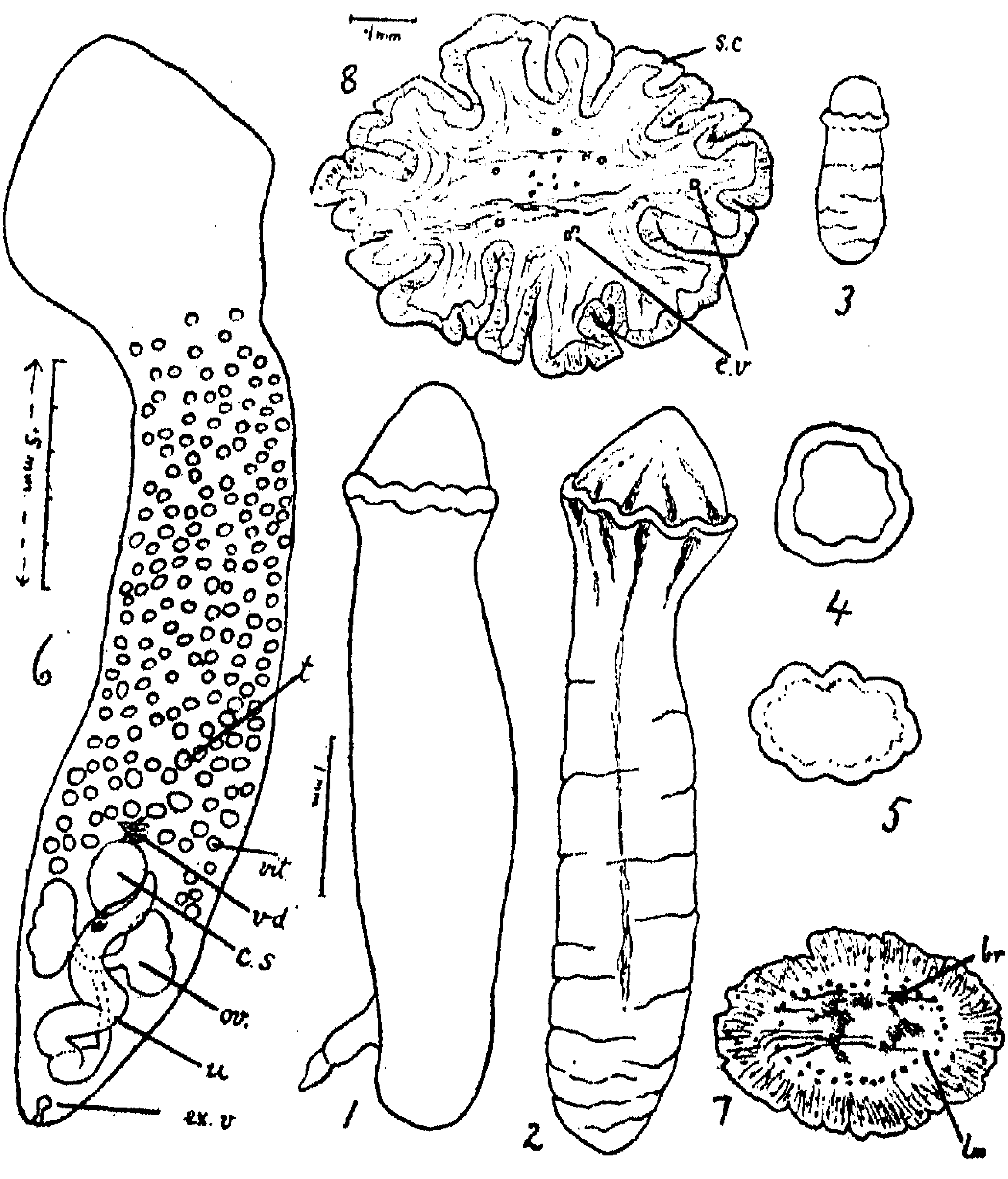
[Read 27th August, 1924.]

On several occasions Dr. T. L. and Dr. M. J. Bancroft collected a number of small cestodes from the duodenum of a widely distributed Australian Siluroid, the common freshwater jewfish or catfish, *Tandanus tandanus* Mitchell, caught in the Burnett River near Eidsvold, Queensland. These parasites have proved to be the first Caryophyllaeid cestodes recorded as occurring beyond Europe, Asia and North America, and the first members of the family collected from fish other than Cyprinoids. If the genus *Caryophyllaeus* be used in a wide sense, then the name, *C. bancrofti*, n.sp., may be used to designate the new species, but as will be shown below, the worm possesses marked characters which, in the writer's opinion, justify the erection of a new genus to receive it.

The length of preserved specimens measured in formalin, varied from 1.1 to 4.7 mm.; breadth .4 to 1.1 mm. The largest were 4.7 by .8 mm.; 4.6 x 1.0; 4.7 by .9 mm.; and the smallest 1.1 by .4 mm. Worms which were immature, but which possessed complete though small genital organs and vitellaria, measured 1.15 by .45 mm. A few eggs were detected in specimens as small as 2.5 mm. in length, so that considerable growth must occur after sexual maturity has been reached. The dimensions of the parasites depend to some extent on the degree of contraction of the highly muscular body and scolex. The worms are elliptical in cross-section, the transverse diameter being about twice the dorsoventral, though in the posterior region, in the vicinity of the ovary and cirrus sac, the body is rather more rounded in section, the dorsoventral diameter then being about two-thirds of the transverse.

The body surface of preserved material is traversed by many more or less transverse folds or grooves owing to the contraction of the longitudinal musculature. There may also be a more or less prominent longitudinal groove extending backwardly from the scolex for a varying distance, but it is not a constant feature.

The scolex is generally markedly broader than the succeeding neck region, and is usually a little wider than the broadest part of the body, which is in the posterior half. No definite sucking grooves, like those of *Archigetes* or *Glaridacris*, occur, nor is the organ leaf-like as in *Caryophyllaeus*. The anterior part is a short rounded cone and is succeeded (in preserved specimens) by a prominent "frill," constituting the widest region of the scolex. The latter at the "frill"



Figs. 1-8. *Balanotaenia bancrofti*, n.gen. et. sp.

1. Lateral view of adult with extruded cirrus. 2. Ventral view of adult. 3. Smallest specimen observed, 1.1 mm. by .4 mm. (in formalin). 4, 5. End views of scolices (in formalin). 6. General view (dorsal); stained preparation, somewhat compressed. 7. Transverse section of anterior part of scolex in region of brain. 8. Transverse section in region of "frill": note deeply folded surface.

Figs. 1 to 5 have been drawn to the scale indicated beside Fig. 1.

Figs. 7 and 8 drawn to scale beside Fig. 8.

All figures have been drawn with the aid of a camera lucida.

References to Lettering:—*br.*, brain; *c.s.*, cirrus sac; *cu.*, cuticle; *e.*, egg; *e.v.*, excretory vessel; *ex.v.*, excretory vesicle; *f.*, "frill"; *g.a.*, genital atrium; *g.u.*, glandular uterus; *l.m.*, longitudinal muscles; *m.*, muscles; *n.*, nerve; *od.*, oviduct; *o.i.*, ovarian isthmus; *ov.*, ovary; *r.s.*, receptaculum seminis; *s.c.*, subcuticula; *s.g.*, shell gland; *t.*, testis; *t.m.*, transverse muscle fibres; *u.*, uterus; *u.a.*, uterine opening into genital atrium; *u.c.*, uterine cavity; *u.d.*, uterine duct; *v.*, vagina; *v.d.*, vas deferens or vesicula seminalis; *vit.*, vitelline follicle; *vit.d.*, vitelline duct.

may vary in size as the following measurements of large parasites show:—.7 mm. across by .5 mm. in thickness; 1.1 by .75; .85 by .85 mm. In life this part is probably highly mobile, but in the material examined it appeared as a thick muscular projecting fold exhibiting an undulating edge, the depressions or grooves between the rounded edges being sometimes comparatively deep and extending anteriorly as well as posteriorly into the neck. These ridges are variable in number, though in most specimens examined about ten were present. This expanded portion is abundantly supplied with muscle fibres inserted into it. The scolex narrows somewhat posteriorly, but a distinct neck region is hardly recognisable since the most anterior vitelline follicles lie very close behind the "frill."

The position of the sex openings seems to vary with the degree of contraction of the parasite, but is always near the posterior end. The genital atrium, into which the vagina and uterus open, is a more or less narrow transversely elongate slit, commonly crescentic, situated ventrally in the vicinity of the ovarian isthmus. The male aperture is included within the atrium when the cirrus is at rest. In a worm 4.5 mm. long the atrium was situated at .5 mm. from the posterior end, i.e., at one-ninth the body length; in another (4 mm. long) at one-seventh; in another (2.7 mm. long) at one-eighth; in another (2.4 mm. long) at one-seventh; and in another (3 mm. long) at one-twelfth the total body length from the posterior extremity.

The smooth cuticle, 4 to 7 μ thick, is succeeded by a definite basement membrane. The subcuticula occupies a wide zone and consists of rather closely arranged narrow elongate cells with prominent nuclei situated at different levels. There is a ring of delicate longitudinal muscle fibres just below the basement membrane. Calcareous corpuscles are absent.

The main longitudinal series of muscle fibres is almost central, forming a well-defined zone inwardly from the testes and vitellaria, but in the posterior region of the worm the system is feebly developed. The central portion of the zone is occupied by parenchyma traversed by comparatively few transverse fibres and by very few dorsoventral fibres. There is no tendency for the longitudinal fibres to become aggregated into bundles, except in the anterior part of the scolex, where such are very small and numerous. Passing outwardly from the main musculature, there are seen in sections abundant fibres traversing the region between the testes and between the vitellaria to reach the subcuticula. In the posterior part of the scolex, the longitudinal muscles occupy a very considerable region of the parenchyma, forming a wide elliptical zone within which are transverse fibres. The arrangement of the longitudinal musculature is thus characteristic in that it occupies a well-defined region between the dorsal and ventral testes, instead of the position usually met with, outwardly from the vitelline region.

The nervous system is generally ill-defined. The main longitudinal nerve lies in the parenchyma near the inner ends of the laterally placed vitellaria. In the region of the ovary it is dorsolateral to the corresponding ovarian lobe. In the anterior part of the scolex there is a bilobed (perhaps ring-like) mass of nervous tissue, from which fibres radiate into the cortex. The second ring commissure in the scolex and the commissure in the vicinity of the excretory vesicle, described as occurring in some Caryophyllaeids, were not observed.

The excretory system comprises about eight chief longitudinal canals lying within the testicular and vitelline zones, but outwardly from the ovary, uterus and cirrus sac. Two laterals on each side are the largest. Numerous connecting

vessels having a sinuous course are to be seen exteriorly from the longitudinal musculature. The canals apparently form four trunks which terminate in the rather large excretory vesicle lined by cuticle and extending inwards from the extremity of the worm for from .07 to .1 mm. The outer portion is more or less tubular, while the part into which the canals empty, is expanded, measuring from .05 to .075 mm. in diameter. The vesicle may extend anteriorly to lie below the most posteriorly directed loop of the uterus.

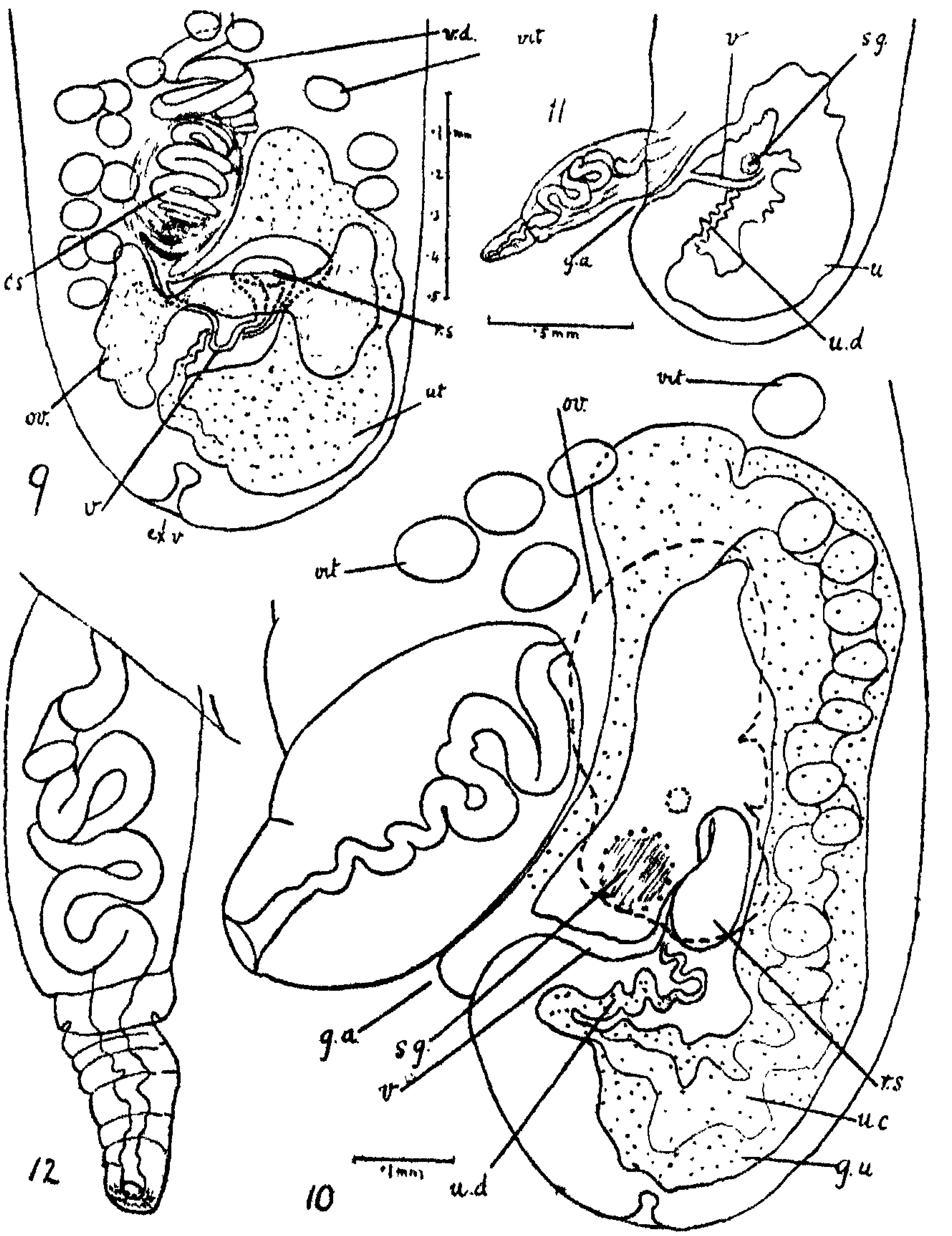
The testes are very numerous, .10 to .07 mm. by .04 to .07 mm. in size, lying in the parenchyma at a deeper level than the vitellaria. Five or six are commonly seen both dorsally and ventrally in each trans-section of the body, but they do not extend laterally beyond the main longitudinal nerves, though vitelline follicles are abundant in that zone, as well as above and below the testes. The present species thus differs from most of the described Caryophyllaeids in that the median zone is not free, or comparatively free, from vitellaria. They do not extend as far posteriorly as the latter, though they may reach the vicinity of the cirrus sac, where they may be seen laterally to it as well as to the uterus; nor do they extend quite so far anteriorly, though both testes and vitellaria occur very close behind the broadened portion of the scolex. The testes stain less deeply than the vitelline follicles, and each appears as an elliptical organ with a narrow lining of sperm mother cells, while in the cavity there may be seen little rounded masses of developing sperms.

In mature specimens a large coiled vesicula seminalis is to be seen lying in the middle of the medulla and bounded by the longitudinal musculature immediately anteriorly to the cirrus sac. Its diameter may reach .04 mm. The cirrus sac, which measures about .3 by .23 mm. in a fully retracted condition, occupies a large part of the medulla and is surrounded by the vitellaria, while laterally to its proximal part there may be testes. The organ is overlain distally by the uterus. The wall of the sac contains a comparatively small amount of muscle fibres, as also does the wall of the contained male duct. Fibres traverse the loose parenchyma of the organ. Within the sac, the duct is thrown into a number of coils which are very wide in the middle and proximal thirds of the organ, narrowing in the distal third, this portion being the eversible cirrus. The latter was quite smooth. The male opening, as already stated, may open into the anterior part of the genital atrium, but when the cirrus is more or less everted, the female portion of the atrium comes to open immediately behind its base.

In several specimens the cirrus was seen more or less extended and directed ventro-posteriorly. An everted organ projected .55 mm. from the ventral surface of a worm measuring 4.75 mm. in length, the width in its basal half being .2 mm., at the tip .05 mm. The organ was obviously not completely protruded, its full length being probably .67 mm., about one-seventh as long as the parasite. The basal portion enclosed the cirrus sac with its contained swollen and coiled vesicula, while in the narrower tapering distal half (evidently the true cirrus) the duct was smaller and merely sinuous.

In another instance where the cirrus was partly protruded posteroventrally (.44 mm. long) the barrel-shaped base measured .35 mm. in width, and contained the wide coiled male duct. The genital atrium was displaced posteriorly so as to lie well behind the ovarian isthmus, while the cirrus sac occupied practically all the region ventrally between the ovarian lobes.

The most anterior vitelline follicles lie almost immediately behind the widest



Figs. 9-12. *Balanotaenia bancrofti*, n.gen. et sp.

9. Posterior end, showing anatomy, viewed ventrally and slightly obliquely: shell gland, vitelline duct, oviduct and also the testes and vitellaria in the vicinity of uterus and cirrus sac are omitted. 10. Lateral views of posterior region, examined in clove oil; showing partly extruded cirrus; outline of ovary and position of commencement of oviduct indicated by broken lines: position of shell gland marked by dots surrounding a shaded area: the thick walls and sinuous lumen of the uterus are indicated. Most of the vitellaria have been omitted. 11. Posterior end of a specimen examined in clove oil: cirrus and sac almost fully extended. Lateral view. 12. Extruded cirrus and sac of specimen figured in Fig. 11—drawn to same scale as Fig. 10.

(For lettering see page 340).

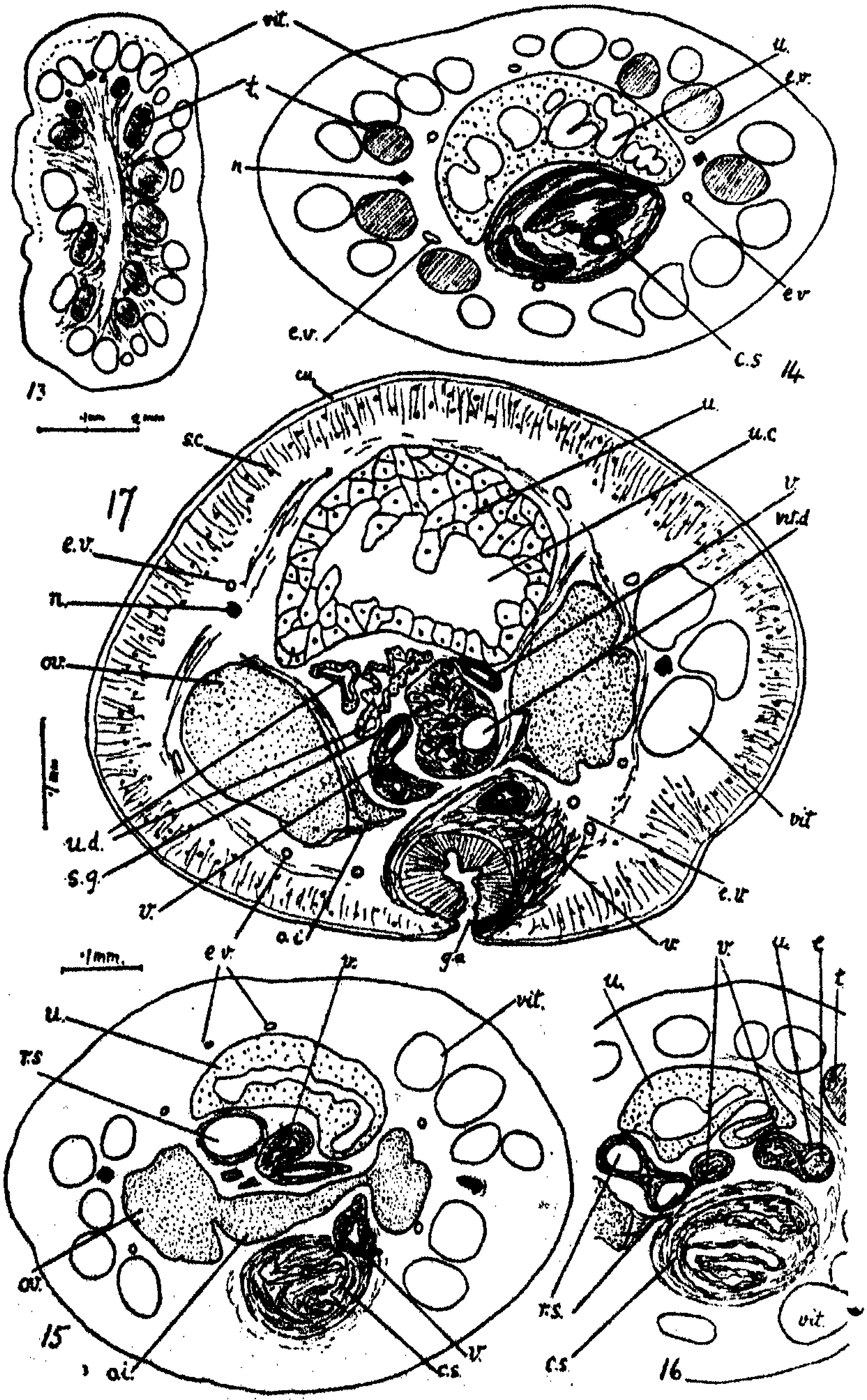
part of the scolex, whereas in other described species of *Caryophyllaeus*, as well as *Glaridacris*, there is a considerable interval behind the scolex free from them. They are very numerous, measure .02 to .035 by .035 to .09 by .04 to .08 mm., and are not restricted to the lateral parts of the parasite, but are also distributed along the median regions ventrally and dorsally. They extend as far back as the anterior part of the ovary, which they may overlie and underlie. They are found above and below, as well as laterally to, parts of the retracted cirrus sac, and also above the preovarian portion of the uterus. The species is characterised by the entire absence of follicles in the postovarian region of the body, thus differing in this respect from every other described species belonging to the Caryophyllaeidae.

Vitellaria at first sight resemble the testes, but usually become more deeply stained. They are, however, readily distinguishable from them, since the constituent cells lying in the middle of the mature follicle are large and contain abundant small deeply-staining rounded granules, more or less peripherally situated, while surrounding the nucleus is a comparatively wide clear zone. The peripheral cells are smaller, and the contents less obviously granular, though the cytoplasm stains more deeply than in the large cells which represent subsequent stages in the development of these yolk cells.

The vitelline ducts were not traceable in front of the ovary, but immediately behind the isthmus they form a fairly wide tubular common yolk duct or reservoir, lying somewhat transversely between the isthmus and the vagina, and immediately below and in front of the shell gland which it penetrates somewhat ventrally and on the left side. In one instance the reservoir measured .1 by .04 mm., but is generally much shorter. It joins the ootype within the shell gland.

The ovary lies in the vicinity of the genital openings, whereas in all other described members of the family it is situated at varying distances between the atrium and the posterior end of the worm. The opening of the atrium in *C. bancrofti* generally lies immediately in front of the isthmus and between the anterior ovarian lobes, while the atrium itself (the vaginal portion of it) passes below the ovary and at times the openings of the uterus and vagina into the atrium may be below the isthmus. The ovary is compact, each lobe being rounded or slightly lobulate and rather narrow, measuring .14 to .4 mm. in length. The general appearance is like that in *C. tuba*. The isthmus is approximately tubular, arched slightly, with the concavity directed dorsally and somewhat anteriorly, and lying in the middle of the worm between the atrium or vagina and the uterus. Above it, or just in front of it, is the receptaculum seminis, while the shell gland is dorsoposterior. An extremely short oviduct arises from it posteriorly and travels slightly dorsally towards the right to become joined by the vagina. This ootype still proceeds posterodorsally, becoming narrow, thin-walled, and surrounded by the cells of the shell gland, and is then joined by the vitelline duct. The ootype is now a narrow uterine duct which travels to the right and posteriorly, becoming thrown into a series of loops lying between the shell gland and the larger succeeding part of the uterus. The shell gland is rounded and comparatively large, measuring about .1 by .1 mm. with a dorsoventral diameter of .07 mm.

The greater part of the uterus lies behind the isthmus, and most of this portion, together with part of the preovarian region, is characterised by the presence of very thick walls composed chiefly of large cells with readily staining cytoplasm. It has been suggested that these are probably glandular. The thickness of the



Figs. 13-17. *Balanotaenia bancrofti*, n.gen. et sp.

13. Transverse section of mid-region—ventral surface towards right. 14. Section across uterus and cirrus sac. 15. Part of section, behind Fig. 14, showing relation of sex ducts, also junction of vagina and uterus with genital atrium. 16. Section behind 15. 17. Section behind 16, drawn to larger scale, showing opening of genital atrium, also shell gland complex.

Figs. 14, 15 and 16 drawn to scale indicated beside Fig. 15.

wall is often equal to that of the lumen in this region of the organ. Within this thickened tissue the cavity may be thrown into a series of gentle undulations. The uterine duct proceeds posteroventrally to become the "glandular uterus," which, in the vicinity of the excretory vesicle, forms a large loop and then travels forward as a spacious tube dorsally to the shell gland, vagina, ovary and receptaculum seminis. Sometimes this portion lies rather to one side, especially when it contains a few eggs. The tube now becomes thin-walled and widened, assuming a sinuous course and extending forward above the distal portions of the cirrus sac. When the cirrus is extruded the uterus may extend considerably in front of and above the entire sac and above portion of the swollen vas deferens or vesicula. It eventually narrows, bends downwardly and posteriorly between its own ascending limb and the cirrus sac. Its terminal portion is a narrow thin-walled duct, little wider than the breadth of a ripe egg, and ending in the genital atrium which it enters to the left of the vaginal aperture. The uterus thus has a position in the animal quite different from that described as occurring in any other member of the family, and this is correlated with the posterior location of the genital apertures, so that the whole organ has become pushed posteriorly, apparently at the expense of the postovarian vitelline follicles which, as already mentioned, are not represented in this species. The course of the vagina has also become greatly modified for the same reason. The openings of the uterus and vagina into the atrium are both on the left of the median line, the junction occurring in the medulla below the level of the isthmus but above the levels of the distal portions of the cirrus sac, and, as already mentioned, the junction may occur in front of or even behind the isthmus.

The walls of the atrium are thick and lined by cuticle, there being no marked change as it becomes the vagina, while the same kind of tissue surrounds the male aperture as well. The atrium resembles that described for *C. laticeps*.

The vagina travels backwardly, more or less in line with the genital atrium, and lies on the left of the midline, below the level of the ovarian isthmus, turning upwards just in front of the latter, and curving over it near the left lobe. It then becomes thrown into wide loops between the shell gland and the uterus, crossing to the right and then travelling forwards above the isthmus, in the vicinity of which it is sharply bent to enter the rather large receptaculum seminis. The duct is a well-defined tube with relatively thick walls and chitinous lining. The receptaculum is a more or less elliptical organ lying adjacent to the right ovarian lobe and partly or wholly in front of the isthmus and above its level, but below the uterus. It measures .17 by .07 mm., with a maximum diameter of about .08 mm. From its outer end, i.e., on the right side, there passes inwards the narrowed short vagina which joins with the oviduct and soon enters the shell gland. Practically the whole of the course of the vagina is thus behind the ovarian isthmus. In other known Caryophyllaeidae most of its course lies in front of that organ and the tube is not thrown into a pronounced transverse course, but has a longitudinal sinuous one. The presence of a receptaculum has been reported as occurring in only one species of *Caryophyllaeus*, *C. laticeps*.

Eggs are oval to elliptical, measuring .03 to .042 by .025 to .03 mm. The operculate shell is moderately thick and abundantly stippled, probably owing to the presence of a great number of minute processes on its surface. The larval stages are probably passed through in freshwater oligochaetes.

The family Caryophyllaeidae at present contains three genera, *Caryophyllaeus*, *Archigetes* and *Glaridacris*. Four valid species of the first are recognised, all of

them occurring as parasites of Cyprinidae; *C. laticeps* Pall. (syn. *mutabilis* Rud.) from many genera of Cyprinoid fish in Central Europe; *C. tuba* Wag. from a European *Tinca; C. fennicus* Schn. from *Leuciscus* from Northern Europe; and *C. syrdarjensis* Skrjabin from a carp, *Schizothorax intermedius* Gnthr. from Central Asia.

The two species of *Archigetes, A. appendiculatus* Ratzel and *A. brachyurus* Mrazek, are both from Central European freshwater oligochaetes. In America the only known member of the family is *Glaridacris catostomi* Cooper of which *Caryophyllaeus larvei* Lamont from the same host species, *Catostomus commersoni* Lcp. (also a Cyprinoid) is evidently a synonym. Its locality is Michigan, U.S.A.

The Australian representative which occurs in a Siluroid belonging to the Plotosidae, differs in its anatomy more widely from *Caryophyllaeus* than does *Glaridacris*, so that it seems advisable to separate *C. bancrofti* generically as the type of a fourth genus within the family. The characters of the latter as defined by Luhe and by Cooper require amendment in order to receive the new species, since the presence of a postovarian group of vitelline follicles is not universal in the group.

BALANOTAENIA, n.g. (Text-figs. 1-17).

The new genus, for which the name *Balanotaenia* is proposed, may be characterised as follows:—Caryophyllaeidae; small parasites with anterior end modified to form a scolex devoid of suckers but surrounded by a powerful muscular frill-like expansion thrown into a series of short folds when at rest; genital openings in the vicinity of the ovarian isthmus; vagina largely transverse and mainly postovarian in position; uterus largely postovarian; postovarian vitelline follicles absent. Type *B. bancrofti*, n.sp. from *Tandanus tandanus* Mitchell, Burnett River, Queensland. The type has been deposited in the Australian Museum, Sydney, and paratypes have been donated to the Adelaide Museum.

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Addendum (*1/9/1924*). The writer has just had access to an excellent paper by Woodland (Q.J.M.S., 67, 1923, 435-472) describing new Caryophyllaeids from the Nile (Sudan) and containing a revision of the families of Cestodaria. He has redefined the genus *Caryophyllaeus*, using it in a very broad sense, including *Glaridacris* within it. As defined by him, it would also include *Balanotaenia* as a synonym. It is considered advisable, however, to retain the latter generic name for such species as are devoid of postovarian vitellaria and have a transverse disposition of the vagina. Into this genus would probably fall the immature Caryophyllaeid briefly described (but not named) from a Siluroid, *Auchenoglanis*. His *C. filiformis* from *Mormyrus* also lacks the posterior group of vitellaria and may perhaps also be included. He has erected a new genus *Wenyonia* to receive three new species occurring in the Nile Siluroids, *Synodontis* and *Chrysichthys*.

NOTES ON AUSTRALIAN DIPTERA. No. iv.

By J. R. Malloch.

(*Communicated by Dr. E. W. Ferguson.*)

(Five Text-figures).

[Read 27th August, 1924.]

Family DROSOPHILIDAE.

Since the completion of the manuscript of my paper in which I dealt with this family (These Proc., xlviii., 1923, 611) and before its appearance in print there appeared another paper, by Dr. O. Duda (Ann. Mus. Nat. Hungar., 20, 1923, 24),* dealing with Oriental and Australian Drosophilidae represented in the collection of the Hungarian National Museum. In this paper there are three species described from Australia, *Paradrosophila interrupta, Drosophila biradiata,* and *D. australica.* The first-named genus is not known to me, the second species appears to be a *Scaptomyza,* and the third is close to *inornata* Malloch, but has darker antennae and palpi.

In connection with the above-mentioned paper, it may be pertinent to indicate that, in the opinion of many students, there is too great a tendency on the part of some continental European specialists to split into a multitude of poorly differentiated genera larger groups which have very close structural and biological affinities. This rapid erection of new nomenclatorial units based upon minor structural characters that are appreciable only by the ultra-specialist tends to bring the whole systematic fabric into disrepute. I believe that it is only by the use of characters that one can swear by that the study of entomology, or any other branch of zoology, can enlist the number and the class of students that are essential to the development of a classification that will stand the test of time and biological co-ordination. The splitting and resplitting of generic concepts, unless on outstanding structural or fundamentally distinct biological characteristics, shows frequently neither good science nor good sense, and appears to me to warrant the statement, so often made, that a genus is merely a matter of opinion, whereas it ought to be just as much a matter susceptible to proof as the specific concept.

Most frequently the worker who indulges in these nomenclatorial calisthenics is one who confines his systematic work to one order, suborder, or even to one family, and the narrower the scope of the work, the more indulgence in generic and subgeneric differentiations there is, as a rule. It appears probable that the worker who confines his efforts to a certain group, or to a few small groups, in his enthusiasm for differentiation, forgets the relations of that zoological unit to

* This paper is in the Society's library.—Ed.

the whole. If all the others were judged by the same criteria, and the system carried to its logical conclusion, it would ultimately result in the erection of a genus for each species and the consequent elimination of relationship indices, which the present generic concepts really are.

In presenting the descriptions of new species in this paper, I do not give an extended key to the genera already so treated by me but in all cases I append data which may be used by anyone to locate the species in their proper places in the keys. Later on it may be possible to present a complete key to the species.

Types will in every case be returned to Dr. Ferguson, so that future students may have them available for reference when such is essential.

Genus GITONIDES Knab.

This genus is distinguished from all of those in my previously published key to genera of Australian Drosophilidae by the almost bare arista, all the others having long hairs both above and below. There is a vein separating the discal and second basal cells as in *Amiota*, the face has a low central ridge, there are rather long orbitals on each side which are about equally spaced, the anterior one proclinate, the other two reclinate, there are two sternopleurals, both near upper margin, and the prescutellar pair of acrostichals is well developed.

GITONIDES PERSPICAX Knab.

This is the only species, and it superficially resembles *Drosophila repleta* Wollaston, being marked on dorsum of head and thorax in similar manner. There is a distinct longitudinal band across middle of eye even in dead specimens, the pleura have two or three dark linear vittae, the apex of first vein is not blackened, and the legs are entirely yellow. Length, 3-4 mm.

One female, Sydney. Known from Hawaii and India. Larvae feed amongst mealy aphids, but there is no definite record of their feeding upon them.

Genus LEUCOPHENGA Mik.

Dr. E. W. Ferguson has drawn my attention to the omission of *Drosophila albofasciata* Macquart from my previous paper on this family. This species is evidently a *Leucophenga* and, though described from New South Wales, it is still unknown to me except from Macquart's brief description, a copy of which I give below to facilitate its identification, if possible.

LEUCOPHENGA ALBOFASCIATA (Macquart).

Drosophila albo fasciata Macquart, Dipt. Exot. Suppl. iv., Part 2, 1851, 277.

"Thorace testaceo. Abdomine fusco fascia alba. Capite rufis. Pedibus flavis."

"Long. 1 l. ♂♀. Palpes jaunes. Face fauve, à duvet blanc. Front fauve. Antennes jaunes: style à longs poils. Thorax testacé. Abdomen d'un brun noirâtre; base testacée; troisième segment à bande de duvet blanc au bord postérieur. Pieds jaunes. Ailes claires, à base un peu jaunâtre."

New South Wales.

The description does not fit any of the species in my previous key, nor does it agree with one now before me, which I received from Dr. Ferguson after my paper had gone to press. This last species I describe herein. *Leucophenga leucozona* Duda is closely related to Macquart's species, if not the same as it.

LEUCOPHENGA CONJUNCTA, n.sp.

Male.—Tawny yellow, pleura, apex of scutellum, and the legs paler. Scutellum with a large black spot on each side at base. First abdominal tergite yellow; second blackish-brown, the anterior margin narrowly yellow, the posterior margin with a silvery white line; third tergite blackish-brown, with a yellow mark in centre of anterior margin and the same margin in type narrowly silvery white; fourth tergite blackish-brown, with four large yellowish spots, two on disc and the other two between these and the lateral margins; fifth tergite coloured as fourth, but with a large central yellow spot only. Wings hyaline. Halteres yellow, with a large blackish spot on outer side.

Frons about one-fifth of the head width; ocellar bristles long, the anterior two close together; palpi slightly dilated; cheek linear. Thorax normal; prescutellar acrostichals large. Legs normal. Veins 3 and 4 subparallel apically; second vein approaching costa gradually to apex. Length, 3 mm.

Type and one paratype, reared from mushroom, 3.4.1912, no locality given on label.

This species belongs to the same group as *scutellata* and *poeciliventris* described in my previous paper, but the second (first visible) tergite is bipunctate in the former and tripunctate in the latter, instead of having a broad complete blackish band. There are also some other differences in the markings of the abdomen which distinguish them.

Genus DROSOPHILA Meigen.

The key to the species of this genus, which I previously published, may be elaborated as noted below to include the additional species. Preliminary captions may be added before Caption 1 as follows:

A. Wings with conspicuous fuscous markings in addition to that over the cross-veins . . . . AA.
   Wings without distinct dark markings, at most slightly suffused with dark colour and rarely with the outer cross-vein clouded . . . . 1.

AA. Wing with a large brownish or fuscous spot at apex of second vein, the dark cloud at tip consisting of a brownish suffusion along the apices of third and fourth veins, more or less coalescent in first posterior cell; mesonotum dark brown, with three linear yellow vittae, the median one not reaching anterior margin; scutellum yellow in centre, dark brown on sides of disc; pleura whitish-yellow, contrasting sharply with the dark brown mesonotum . . . . *mycetophaga*, n.sp.
   Wing without a dark spot at apex of second vein, the dark cloud at tip consisting of a broad curved brown patch which extends from middle of third section of costa to just over third vein, and over disc of wing to beyond fourth vein, but leaves a hyaline spot in apex of first posterior cell; mesonotum brown, with two poorly defined paler vittae which are carried over the lateral margins of scutellum, the centre of latter brown; pleura not noticeably paler than mesonotum . . . . . . *polypori*, n.sp.

Except in the matter of possessing two pairs of dorsocentral bristles, these two species might well be referred to the genus *Mycodrosophila*. In fact, there is a reduction in the size of the anterior pair of bristles in some specimens which rather suggests to me that the discovery of more species may yet obliterate this line of distinction and cause a fusion of the two genera under *Drosophila*.

DROSOPHILA MYCETOPHAGA, n.sp.

Male and female.—Frons and face brown, paler on sides and in centre, mouth margin and clypeus blackish, cheeks whitish-yellow; antennae yellow, third segment brown; palpi yellow. Thorax as described in diagnosis, upper anterior angle of propleura, and metanotum brown. Abdomen dark brown on dorsum, a yellow spot in centre of anterior margin of second tergite, one on each side of disc of fifth, and the lateral margins of all yellow. Legs pale yellow. In addition to the wing markings mentioned in the diagnosis both the cross-veins and the apex of first vein are clouded.

Eyes haired; proclinate and upper reclinate bristle long, the anterior reclinate one minute. Thorax with at least six series of intradorsocentral setulae; prescutellar acrostichals absent; scutellum slightly flattened on disc, as long as wide, with four equal marginal bristles. Second vein curved forward to costa apically; last section of fourth vein about 1.5 as long as preceding section; second section of costa about twice as long as third. Length, 2.5-3 mm.

Type, male, and allotype, Ourimbah, N.S.W., November, 1911, on *Polyporus* fungus.

DROSOPHILA POLYPORI, n.sp.

Female.—In addition to the distinctions between the two species listed in the diagnosis the following are noted: Margin of mouth and clypeus yellow like the remainder of face; scutellum shorter and more convex; dorsum of abdomen with two pairs of large yellow spots, one on the fourth and one on the fifth tergite, the lateral margins of tergites not yellow; second vein of wing approaching costa much more gradually. Halteres yellow in both species. Length, 2.5-3 mm.

Type and two paratypes, same data as preceding species.

DROSOPHILA SETIFEMUR, n.sp.

Female.—Shining yellowish-brown. Frons brownish-orange, orbits and ocellar triangle darker and slightly shining; third antennal segment brownish. Thorax not vittate. Abdomen glossy, brownish, paler basally, becoming black apically. Legs obscure yellow. Wings slightly greyish. Halteres yellow.

Lower reclinate bristle small; facial carina sharp and high, not broadened nor flattened below, extending nearly to lower margin of face; cheek linear; eyes hairy; vibrissae duplicated. About eight series of intradorsocentral setulae present; one long and two short sternopleurals. Fore femur with rather closely placed fine setulae beginning a little before middle and extending to apex on posteroventral surface, only the apical setula bristle-like, but not as long as diameter of femur, the anteroventral surface with a similar series of more closely placed and more regular setulae. Inner cross-vein at not less than two-fifths from base of discal cell; third section of costa fully one-third as long as second; outer cross-vein fully 1.5 its own length from apex of fifth vein. Length, 2.5 mm.

Type and three female paratypes, Sydney.

This species runs to Caption 1 in my key already published, but differs from *immigrans*, the only other species with fore femoral setulae, as follows:

Fore femur with short closely placed fine setulae on more than the apical half of posteroventral surface, the longest one, at apex, not longer than the femoral diameter; third section of costa not less than one-third as long as second; facial carina narrow .. .. *setifemur*, n.sp.

Fore femur with four or five widely spaced bristles on the entire length of posteroventral surface, the longest one, at middle, as long as or longer than femoral diameter; third section of costa about one-fourth as long as second; facial carina much broadened below .. *immigrans* Sturtevant.

The new species averages smaller in size and is paler in colour than *immigrans*.

DROSOPHILA NIGROVITTATA, n.sp.

Male.—Frons, when seen from behind, with a broad deep black stripe between the triangle and the narrow pale orbit on each side, the central portion, including ocellar region, grey pruinescent; face tawny yellow, with the antennal foveae darker, and a blackish mark in middle below carina, the vibrissal angles and lower part of cheeks greyish; antennae black, apex of second segment yellowish. Thoracic dorsum black, with four pale grey vittae, with the appearance of having five black vittae; scutellum in type too much damaged to make out clearly how it is marked, but apparently black, with the tip and lateral areas greyish. Abdomen black, markings not evident in type. Legs black, each tibia with a yellow ring at base and another beyond middle; tarsi brownish-yellow. Wings hyaline, with a rather distinct black mark on costa at apex of auxiliary vein. Halteres brownish-yellow.

Upper reclinate bristle long, lower one minute, in line with reclinate one; facial carina high, broadly rounded, extending to lower third of face, ceasing abruptly; eyes short-haired; cheek over one-third of the eye height; vibrissa single. Acrostichal setulae in about four series, confined to the black central vitta; anterior pair of dorsocentral bristles very close to suture. Bristles on posteroventral surface of fore femur confined to apical half, long. Incision at apex of auxiliary vein quite deep, the costa at this point with two long fine setulae; second costal division but little longer than third; second vein running obliquely into costa; last section of fourth vein about 2.5 as long as preceding section, the latter subequal to last section of fifth vein. Length, 1.5 mm.

Type, Sydney, 28 August, 1921.

This species is apparently referable to the genus *Spuriostyloptera* Duda, but I do not consider that genus is entitled to separation from *Drosophila*. The deep incision at apex of the auxiliary vein and the attendant black spot are to some extent present in *Drosophila repleta* and its allies, and this species Duda still retains in *Drosophila*.

In my key to the Australian species, *nigrovittata* will run to *buscki*, having five vittae, but these are broad and black instead of slender and brown. The annulate tibiae and differently coloured frons will readily separate the species so far as colour is concerned. Structurally they differ in *buscki* having no facial carina, and, though the latter also has a very evident notch at apex of the auxiliary vein, there is no black mark present, and the venation is different.

DROSOPHILA ALBOSTRIATA, n.sp.

Female.—Black, slightly shining. Sides of face and frontal orbits white; second antennal segment yellowish, third missing. Thorax with two narrow

white pruinescent dorsal vittae which extend from anterior margin over entire length and on to lateral basal angles of scutellum; humeri yellowish; lateral margins of the mesonotum greyish; pleura brown; tip of scutellum whitish pruinescent. Abdomen more shining than the thorax, basal tergite yellowish, second usually yellow in middle anteriorly, the others with a narrow pale hind margin and a yellow spot on each side anteriorly, the latter visible only when abdomen is distended. Legs pitchy, knees, apices of tibiae, and the tarsi paler. Wings hyaline. Halteres yellow.

Lower reclinate bristle and the postvertical bristles minute; eyes hairy; facial carina broad, rounded, quite prominent; third antennal segment and arista missing in all specimens before me; cheeks narrow. Humerals two; sternopleurals two; six series of intradorsocentrals present, only four of them between the vittae, the other two almost in line with the dorsocentrals, the median two series longer than usual; prescutellar acrostichals small; basal pair of scutellars distinctly shorter than apical pair. Legs normal. Inner cross-vein a little beyond middle of discal cell and apex of first vein; outer cross-vein about 1.5 its own length from apex of fifth; last section of fourth vein about three times as long as preceding section; section of costa beyond apex of second vein nearly half as long as the one in front of it; second vein approaching costa gradually. Length, 2 mm.

Type and eight paratypes, apparently all females, Eidsvold, Queensland. Type and two paratypes mounted on same pin.

It is possible, but improbable, that the antennae will furnish characters that will justify the removal of this species from *Drosophila*, but there are no other characters evident to me which suggest that the species is not properly placed in this genus.

The conspicuous white dorsal lines extending from mouth margin over dorsum of head and thorax to base of scutellum readily distinguish this species from any in my previously published key. *Paradrosophila interrupta* Duda has the thorax marked as in this species, allowing for the oily condition of his type specimen, but is otherwise different.

DROSOPHILA FUSCITHORAX, n.sp.

Female.—Fuscous, thorax subopaque, with very slight greyish pruinescence; abdomen more shining, also slightly grey pruinescent. Frons brown, darker posteriorly, orbits, ocellar region, face, and cheeks greyish pruinescent; antennae brown, third segment black; palpi yellow. Thorax not vittate. Abdomen in type without obvious markings. Legs dirty yellow, bases of coxae darker. Wings slightly greyish. Halteres brownish-yellow.

Eyes with extremely short hairs, only visible against reflected light with a high power lens; facial carina obsolete even between bases of antennae; parafacial invisible from side; cheek linear; no outstanding bristle below vibrissa; lower reclinate orbital bristle minute, in line with proclinate one; arista with 3 + 2 rays. Thorax with two humerals, eight series of intradorsocentral setulae, a short but distinct pair of prescutellar acrostichals, and three sternopleurals, the lower one longest; basal pair of scutellar bristles a little shorter than apical pair. Legs normal. Last section of fifth vein distinctly longer than penultimate section of fourth, and about three times as long as outer cross-vein; last section of fourth vein fully three times as long as penultimate; section of costa before

apex of second vein a little less than three times as long as the one beyond it. Length, 2.75 mm.

Type, Sydney, 13 September, 1923.

This species will run in my key to the first section of Caption 5, but is readily distinguished from *inornata* by its much darker colour, and different venation.

DROSOPHILA FLAVOHIRTA, n.sp.

Female.—Tawny yellow. Orbits and ocellar region slightly shining; face paler than frons. Thorax shining, rarely with traces of four darker, reddish vittae. Abdomen unicoloured. Legs concolorous with body. Wings hyaline. Halteres yellow. All hairs and bristles luteous.

Eyes hairy; lower reclinate bristle small; facial carina sharp only at upper extremity, becoming gradually broader below and very much flattened, sloping off imperceptibly into mouth margin; cheek narrow; one short bristle below vibrissa; palpi rather broad. Thorax with eight series of intradorsocentral setulae; the prescutellar pair of acrostichals not differentiated; scutellars subequal; sternopleurals two; humerals two. Inner cross-vein at middle of discal cell and distinctly beyond apex of first vein; second section of costa about 2.5 as long as third; outer cross-vein about twice its own length from apex of fifth vein, the last section of latter a little shorter than penultimate section of fourth; veins 3 and 4 a little convergent at apices. Legs normal. Length 1.5-2 mm.

Type and ten paratypes, December, 1923, collected on flowers, Como, N.S.W. (H. Petersen).

This species will run to Caption 5 in my key, but may be distinguished from any subsequent species by the entirely yellowish hairs, the hairs and bristles on all the others being largely or entirely black or fuscous.

Its most closely related allies are to be found in the *ampelophila* group. In my last paper I recorded this last species as *melanogaster* Meigen. Duda, who has apparently examined Meigen's type, states that the species are distinct, so that the name *ampelophila* will stand for the Australian species.

Family CHLOROPIDAE.

Since the completion of my last paper dealing with some genera of this family, I have received some additional material from Dr. E. W. Ferguson, and from Dr. C. F. Baker. This material contains some undescribed species, some of which are dealt with herein.

Genus GAURAX Loew.

Becker considers that *Batrachomyia* Skuse is a synonym of this genus. I have not seen the genotype of the former, but I believe Becker has stretched the definition of the genus beyond reasonable limits to accommodate this view. *Gaurax* is a very poorly differentiated genus, being distinguished from *Oscinis* Auct., and *Siphonella* only by the distinctly short-haired arista. To this character Becker has added, in his paper on the Australian Chloropidae, another, the shape of the third antennal segment, which is not borne out by the genotype. This variation in the definition of a genus in different faunal regions is not permissible, the only criteria being the characters possessed by the genotype. Based upon the latter dictum, we have a genus which is, as already stated, distinguished

from *Oscinis* only by the more distinctly haired arista, that of the latter being at most pubescent, while in *Gaurax* it is short haired. That this character is not a reliable one is clearly shown by the fact, that Loew placed one or more species in *Oscinis*, which later Becker removed to *Gaurax*.

The genus *Siphonella* is yet more closely related to *Oscinis*, though the genotype appears to be abundantly distinguished by its long geniculated proboscis and angulated vibrissal angle. The degree of elongation and geniculation, as well as the chitinization of the proboscis, is quite variable within this particular group and it is extremely difficult to place some of the species, or individuals of some species, in one or the other genus. This will be evident when it is explained that Becker described one North American species in *Siphonella* and *Oscinella* (*Oscinis*), under different specific names.

Possibly the three genera ought to be associated under one generic name. This paper is, however, not the proper place to consider this matter so I leave it for future consideration, possibly by another worker.

Gaurax atriseta, n.sp.

Female.—Head ferruginous, upper half of occiput and frontal triangle shining black; antennae yellow; arista black and black haired. Thorax ferruginous, dorsum with three slender blackish lines which are connected at anterior and posterior extremities, the lateral lines less distinct than the central one in type; base of scutellum blackened; centre of postnotum broadly black, shining. Abdomen shining black, basal segment yellowish. Legs tawny yellow. Wings slightly brownish, veins black. Halteres yellow. Cephalic and thoracic hairs black, those on legs paler.

Frons distinctly wider than either eye, and about as long as its greatest width, the hairs quite long, almost bristle-like and not very numerous; triangle extending four-fifths of the distance to anterior margin of frons, the ocellar and postvertical bristles cruciate; longest hairs on arista about twice as long as its basal diameter; eyes hairy; cheek almost linear. Mesonotum with the hairs suberect and moderately long; scutellum subtriangular, with four marginal bristles and some erect discal hairs. Legs normal, rather longer haired than usual. Last section of fifth vein over three times as long as outer cross-vein and a little longer than penultimate section of fourth. Length, 3 mm.

Type, Sydney, 31 December, 1923.

Of the yellow species from Australasia, which Becker puts in this genus, the new one comes closest to *quadrilineatus* Skuse and *nigritarsis* Skuse. The former has the arista bare, and the latter has the antennae and some parts of the legs black. He lists no other species from Australia though there are some from New Guinea.

Genus Caviceps, nov.

Generic characters.—Frons without a differentiated triangle extending beyond ocellar region; postvertical bristles distinct, slightly incurved; face deeply concave, with two rounded antennal pits separated by a slight ridge, most conspicuous above; mouth margin slightly produced (Fig. 1); palpi long, slender, slightly curved; one short vibrissal setula present. Thorax with four bristles on hind margin in front of scutellum, the latter slightly longer than usual, flattened

above and with numerous short stiff setulae, except on median line. In other respects similar to *Oscinis*.

Genotype, the following species.

CAVICEPS FLAVIPES, n.sp. (Fig. 1).

Female.—Head whitish-yellow, upper occiput and ocellar region grey; antennae and palpi yellow; clypeus blackish. Thorax opaque black, densely pale grey pruinescent, with three poorly defined dark dorsal vittae; scutellum yellowish apically. Abdomen pale tawny yellow, with a darker dorsocentral vitta which tapers apically, the apices of tergites whitish, and their bases darkened laterally. Legs yellow, mid tibia with a faint brown spot at middle. Wings hyaline. Calyptrae yellow. All hairs and bristles yellowish.

Frons a little wider than one eye, about one-third longer than wide, covered with short hairs, except on a median line posteriorly; eyes densely haired, distinctly higher than long; parafacial almost linear; cheek about as high as third antennal segment, the latter rounded; arista sub-nude. Dorsum of thorax rather densely covered with short stiff sub-decumbent hairs; scutellum with two apical bristles. Legs rather stout, normal, hind tibial sensory area pale. Inner cross-vein about middle of discal cell and well proximad of apex of first vein; outer cross-vein nearly twice its own length from inner; last section of fifth vein about twice as long as penultimate section of fourth and two-thirds as long as last section of that vein; section of costa beyond apex of second vein about one-third as long as preceding section. Length, 2.25 mm.

Type, Sydney 19 February, 1924.

This species appears to find its closest ally in *Oscinella* (*Oscinis* auct.) *defecta* Becker, described from Java, but that species has the face shining black in the antennal foveae, and the hind femora and tibiae indistinctly browned in middle. I consider *defecta* belongs to this genus.

Genus TRICIMBA Lioy.

This genus is similar to *Caviceps* in some respects, but differs in having the frontal triangle distinct, the thorax with three deeply impressed lines of punctures, the prescutellar acrostichals lacking, and the postscutellum minute instead of well developed. *Notonaulax* Becker is a synonym.

TRICIMBA CARINATA, n.sp.

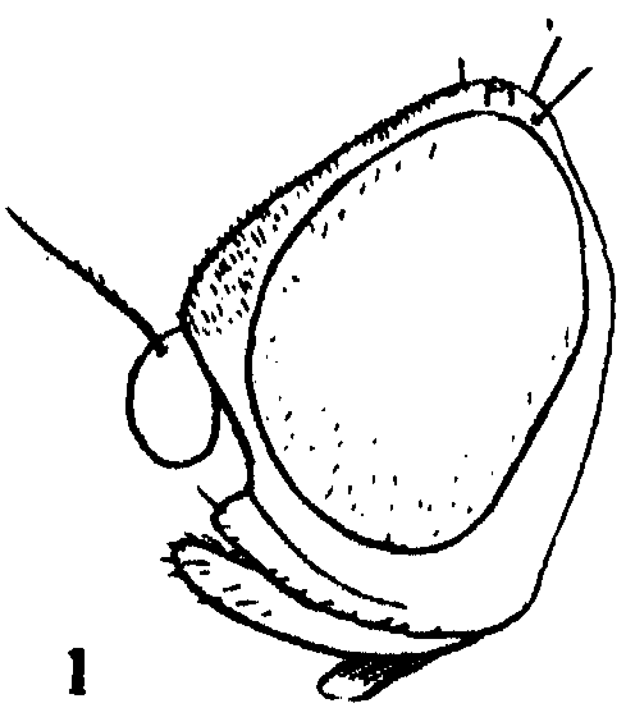
Female.—Head blackish-grey, anterior margin of frons, face, antennae, cheeks, and palpi yellowish. Thorax black, densely grey pruinescent, shining only where it is rubbed. Abdomen black, shining, lightly grey pruinescent. Legs yellow, all femora and the hind tibiae broadly fuscous at middle. Wings hyaline. Halteres yellow.

Frons nearly one-half of head width, slightly protuberant in profile; face concave, with a short blunt carina in middle, which does not extend to mouth; vibrissal angle slight; cheek about two-thirds as high as third antennal segment; arista pubescent; eyes hairy. Thorax with pale microscopic hairs, the central furrow single, the lateral pair broadened posteriorly; scutellum flat above, with numerous depressed pale setulae on disc, and four short apical setulae. Third

section of costa nearly one-half as long as second; inner cross-vein almost below apex of first. Length, 1.5 mm.

Type, Como, N.S.W., December, 1923, on flowers (H. Petersen).

Tricimba marina Becker, from Formosa, has the frons not wider than either eye and the halteres black-brown; *T. fascipes* Becker, also from Formosa, has the thoracic dorsum and lower part of pleura shining black, with the disc of the former opaque brown. The face in the new species is more distinctly carinate than in the genotype, *cincta* Meigen, from Europe and North America; and



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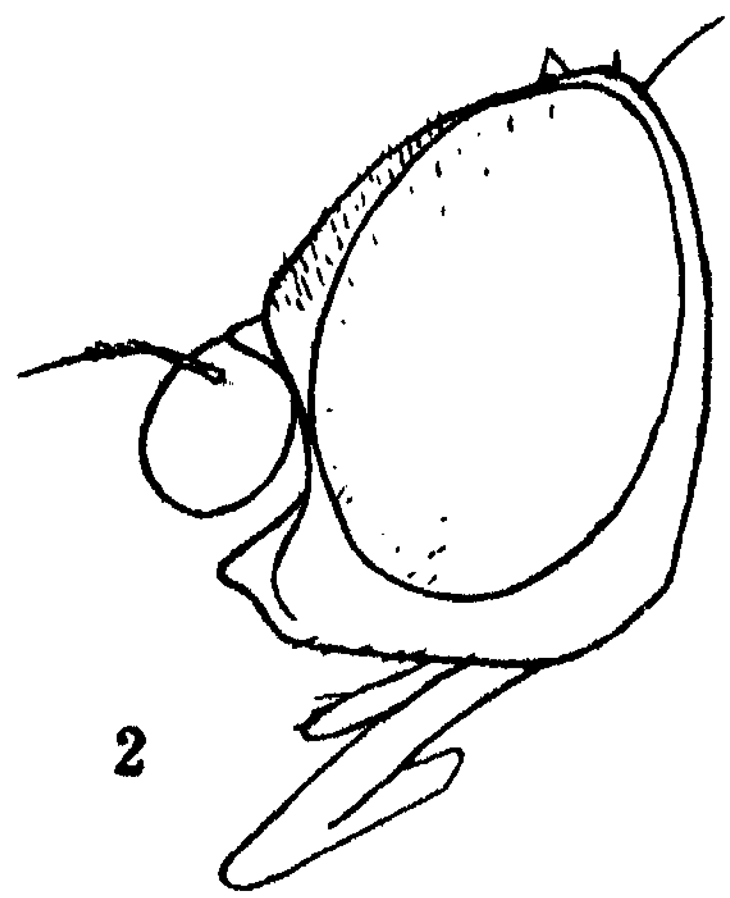

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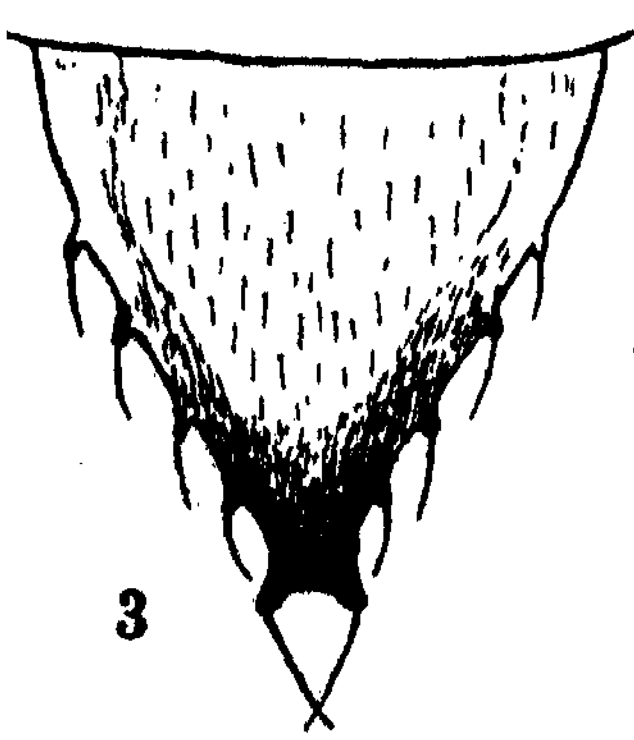

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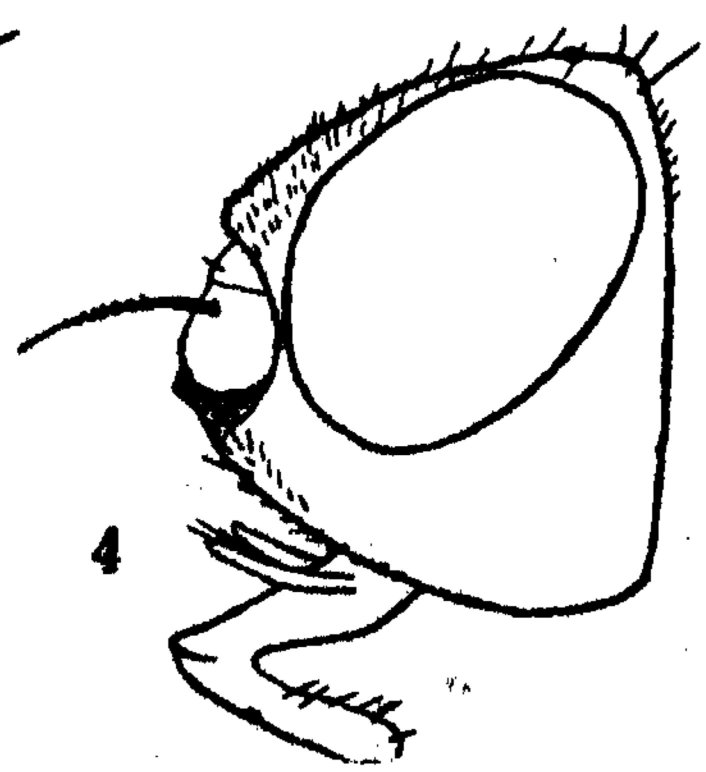

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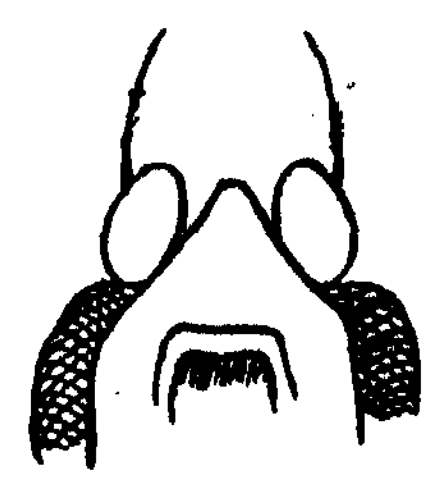

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Fig. 1. Head of *Caviceps flavipes* from the side.
Fig. 2. Head of *Thyridula atroapicata* from the side.
Fig. 3. Scutellum of *Thyridula atroapicata* from above.
Fig. 4. Head of *Deltastoma unipunctata* from the side.
Fig. 5. Outline of anterior margin of head of *Deltastoma unipunctata* from below.

spinigera Malloch, from North America, has the scutellum armed with setigerous tubercles and the face almost without a carina. The South American species, *palpalis* Becker, has the legs entirely yellow, and *similis* Enderlein, from the same region, has the abdomen brown with the basal two segments yellow.

Genus Thyridula Becker.

This genus was erected for the reception of a species from New Guinea. It is close to *Rhodesiella* Adams (*Meroscinis* de Meijere), described from Africa, and well distributed over the Orient. It is distinguished from it by the hairy eyes, very small, poorly defined frontal triangle, and produced vibrissal angles (Fig. 2). The elongated scutellum with its setigerous tubercles distinguishes these genera from others already dealt with by me in this series of papers. They belong to the subfamily Oscininae.

Thyridula atroapicata, n.sp. (Figs. 2, 3).

Male ?.—Head tawny yellow, frons a little brownish, ocellar region and upper half of occiput, except a postvertical triangle, black; antennae and palpi yellow. Thorax yellow, with three broad black vittae and a lateral postsutural spot on dorsum; sternopleura, mesopleura, pteropleura, and hypopleura each with a large shining black mark; scutellum paler than mesonotum, black at apex. Abdomen tawny yellow, infuscated on sides of each tergite. Legs tawny yellow, hind tibia browned at middle anteriorly. Wings clear. Halteres yellow.

Frons subquadrate, a little wider than either eye, with rather abundant short pale hairs, ocellar and postvertical bristles erect, minute, convergent; profile as in Figure 2; arista nearly bare. Mesonotum granulose, depressed on pale areas, the hairs short, numerous, decumbent and pale; scutellum as in Figure 3, the setulae along sides black, the hairs pale; mesopleura with microscopic pale pile. Abdomen short and broad. Legs stout, hind tibia stouter than mid. Inner cross-vein much proximad of apex of first vein; outer cross-vein oblique; veins 3 and 4 not convergent apically. Length, 3 mm.

Type, Bowral, February, 23.

The only other species, *breviventris* Becker, has the thorax black instead of yellow in ground colour, and differs in some other respects.

Genus Siphunculina Rondani.

This genus is distinguished from its allies by the very short second vein of the wing, the second costal division being about as long as first and not over half as long as third. In other respects the genus is similar to *Oscinis* auct.

Siphunculina breviseta, n.sp.

Female.—Shining black, without grey pruinescence. Antennae brownish-yellow, third segment darker on upper and apical margins; palpi and legs brownish-yellow, coxae, femora, except extreme apices, and a median annulus on hind tibiae black, fore and mid tibiae sometimes faintly darker at middle. Wings hyaline. Knobs of halteres brownish-yellow, darker apically.

Frons microscopically longitudinally strigose laterad of the triangle, and with some very short stiff setulae inserted in punctures, most distinct along sides of the triangle, a pair of short stout bristles on vertex behind ocelli and another at anterior ocellus; antennae normal in size, but sunk in cavities on each side of a broad median elevation which occupies at upper margin fully one-third of the space between eyes, becomes narrower at middle of face, where the upper half is differentiated from the lower by a slight depression of the latter; arista bare; labrum elevated in middle; cheek narrow. Disc of mesonotum and of scutellum

microscopically shagreened and with rather closely placed slight elevations which are surmounted by short decumbent hairs; notopleural bristles very short and stout, 1:1; margin of scutellum with about 8 very short stout setulae or thorns, which are situated on slightly elevated bases; mesopleura rugose posteriorly and with a few short hairs on hind margin. Abdomen microscopically shagreened. Legs normal. First and second sections of costa subequal in length. Length, 2 mm.

Type and 8 paratypes, Como, N.S.W., on flowers (H. Petersen).

The facial carina is more distinct than in the genotype, and the very short marginal setulae on the scutellum distinguish it from almost all species of the genus, only one having these similar, but it has the frons largely opaque.

Genus DELTASTOMA, nov.

Generic characters.—Similar to *Siphonella*, but the face with a conspicuous carina on lower half and a groove on either side in which the antennae lie, the anterior mouth margin not transverse, but produced V-shaped (Figs. 4 and 5). Eyes hairy; arista pubescent; vibrissae undeveloped; orbital hairs weak; notopleurals 1 + 3; dorsocentrals confined to one prescutellar pair, with a number of setulae between them transversely; scutellum normal. Legs and wing venation normal.

Genotype, the following species.

DELTASTOMA UNIPUNCTATA, n.sp. (Figs. 4, 5).

Female.—Tawny yellow, ocellar spot, arista, and a spot between apices of second and third wing-veins black; abdomen browned on dorsum apically.

Head as in Figures 4 and 5. Dorsum of thorax with rather dense short black setulose hairs; scutellum with two long and some shorter bristles, the disc with some short hairs. Legs stout. Third vein of wing a little concave below the black spot, fourth ending almost in wing tip, a little deflected apically; inner cross-vein almost below middle of first costal division and distinctly before middle of discal cell; outer cross-vein over three times its own length from apex of fifth vein; *second section of costa about 2.5 as long as third. Length, 3 mm.*

Type, Sydney, N.S.W., 2.11.23.

The peculiar shape of the mouth opening when viewed from below distinguishes this genus from any in either the Oscininae, to which it belongs, or the Chloropinae.

A REVISION OF THE AUSTRALIAN CHIROMYZINI (STRATIOMYIIDAE. DIPTERA).

By G. H. Hardy.

(Seventeen Text-figures).

[Read 30th July, 1924.]

Introductory Note. (Written January, 1924).—When this paper was nearly completed, Dr. E. W. Ferguson received for publication from Professor M. Bezzi, a criticism of Enderlein's genera and species. In view of the early publication of my larger paper dealing with the same subject, Professor Bezzi has since decided to withdraw his contribution. Nevertheless he had expressed views and made critical remarks which forestall some opinions and synonymy here recorded, and, as I have been guided in more than one point by opinions expressed in the manuscript, I publish the following extracts:—

Referring to Enderlein's system of using wing venation, a variable character, in dividing the group into subfamilies and tribes, Professor Bezzi rightly points out that different specimens of "the same species may be enclosed in different subfamilies and tribes."

In view of the possibility of separating the Australian from the South American species of *Chiromyza,* he suggests "the generic name *Archimyza* may thus be used for the Australian species of *Chiromyza* if they are not congeneric with the American ones."

Dealing with Enderlein's tribe Xylophagini he says, "But in this same tribe Dr. Enderlein has erected a new genus *Psegmoptera* for some subapterous females from Australia distinguished in two species, *aurifrons* the type species and *machiliformis.* From the description it is evident that this genus is the same as *Boreoides* Hardy, the type species *aurifrons* being equal to the type species *subulatus.*"

"It is not clear why Dr. Enderlein has placed his genus *Psegmoptera* with the *Xylophagini,* in as much as the winged males, unknown to him, have a two branched media and thus belong to his tribe *Metoponiini.*"

My first paper revising the Tribe Chiromyzini (These Proc., 1920) dealt chiefly with the synonymy of the genera of the world. At that time, unknown to me, Dr. Gunther Enderlein and Professor M. Bezzi were also engaged upon revisional studies in this tribe. Dr. Bezzi received my paper before the publication of his and he has disagreed with some of my suggestions regarding the synonymy of certain genera. The most important matter which Dr. Bezzi would amend regarding the Australian material is the utilisation of the name *Chiromyza*

for Australian species, and he considered all the Australian forms other than those of *Metoponia* might have to be placed under the genus *Boreoides* (see introductory note above for a modification of this view).

Enderlein, on the other hand, has placed every species known to him, including *Metoponia*, numbering five in all, in different genera, and, moreover, he does not recognise their position in the tribe *Chiromyzini*, but distributes the five species among three other tribes. The material studied by Enderlein, consisting of one or two specimens in each case, was too small for him to have realised the great variation in venation that is found in a series of most species,—a variation that is maintained in those he described as new, according to the more abundant material before me. The structures he used in forming his elaborate system of classification prove to be very unstable and unsuitable, for it is possible to find, within a series of one species, characters that would make the different individuals fit, not only Enderlein's different genera, but also his different tribes.

Unfortunately, neither Bezzi nor Enderlein has given a character or a combination of characters that would be adequate to separate completely the Australian from the South American forms of the genus *Chiromyza*, nor have I been able to detect any, so, until they are available, it seems advisable to retain the better-known generic names and to await further evidence before introducing new ones.

It is impossible to determine definitely, from examination of pinned specimens, the exact number of annulations in the antennae. Even when they are examined under the microscope the number may appear different from that shown by prepared micro-slides. For instance, Macquart and Enderlein both give eight annulations to the third segment of the antennae in *Metoponia*, and this is apparently correct; nevertheless, all micro-preparations which I have examined indicate seven at the most.

Amongst the new features of this paper, which must be regarded as an appendix to the former one, I have introduced the proportional length of the first segment of the posterior tarsi in relation to the second segment and the tibia of the same limb; this affords a reliable clue to the identification of specimens. Many specimens were measured for the purpose, but only one of each sex (the types when available) are given in the accompanying table (p. 362). Other specimens vary widely in actual measurements but the proportions remain constant.

The references and synonymy given here are limited to additional ones relating to Australian material only, and with regard to the synonymy given in my original revision the following may be adjusted:—

Inopus despectus Walker may have to be removed from the synonymy of *Metoponia*. Bezzi gives this species (originally described without a locality) as from South America, but I do not know his reasons for so doing.

Hylorus Philippi may be removed from the synonymy of *Chiromyza*, as this South American genus is considered by both Enderlein and Bezzi to be distinct.

Enderlein gives characters for the genus *Nonacris* that would prohibit its inclusion under *Chiromyza* (*sensu stricto*), but Bezzi considers the typical species to be identical with a recognised *Chiromyza*.

By the courtesy of Dr. Bezzi, and Dr. C. P. Alexander, both of whom have supplied specimens, I have found that the typical species of *Allognosta* belongs to the tribe Beridini, despite the absence of scutellar spines. The normal mouth parts are situated on a normal unsunken face and are without the tubercle; also

the female has the typical Beridini abdomen and not that of the characteristic Chiromyzini.

The following table shows the lengths of the tibiae and first two joints of the tarsi on the posterior legs of Australian Chiromyzini:—

	Tibia		Tarsi				
			1st joint		2nd joint		
	♀	♂	♀	♂	♀	♂	Specimens measured.
Metoponia	mm.	mm.	mm.	mm.	mm.	mm.	
rubriceps Macq.	2.	1.8	1.2	1.1	.6	.6	pair in Australian Museum
gemina Hardy	2.6	2.	1.6	1.2	.8	.6	holotype and allotype
Boreoides							
subulata Hardy	3.7	3.2	2.4	2.	1.7	1.	holotype and a paratype male in National Mus. (allotype damaged)
tasmaniensis Bezzi .. .	2.6	2.4	1.8	2.3	.8	1.	female and allotype male in National Museum
Chiromyza							
grandicornis Hardy ..	—	1.7	—	.6	—	.2	holotype
longicornis Hardy .. .	—	1.7	—	1.	—	.5	holotype
australis Macq.	3.1	3.	2.	1.6	.8	.8	pair in Australian Museum
stemmaticalis Enderl.	2.4	2.4	1.6	1.7	.8	.7	female in Queensland Museum and allotype
matruelis Enderl. .. .	3.	2.2	2.1	1.2	.9	.6	female and allotype male
ava Enderl.	3.3	2.3	2.7	1.5	1.2	.9	allotype and female in Queensland Musem
prisca Walk.	2.7	2.	1.8	1.2	1.	.6	allotype female and male in Australian Museum

Since the publication of my earlier paper, and greatly owing to the interest taken in Miss V. Irwin Smith's studies in the biology and anatomy of *Metoponia rubriceps*, the tribe has become well known to Australian entomologists. In consequence, there is scarcely a collection of Diptera from a mountain area that does not bring to light an undescribed species of this group, but, unfortunately, in these collections only one sex is represented. On this account, only one new species is described and it is selected for the purpose because it forms a connecting link between the typical *Chiromyza* and that form originally described as *Xenomorpha grandicornis*, which is also only known from the male.

Key to the tribes of the Beridinae.

1. Abdomen with seven visible segments Subfam. *Beridinae* 2
   Abdomen with five or six visible segments .. *Other subfamilies.*
2. Mouth parts very small, but nevertheless developed; mouth situated on a tubercle placed on a much sunken face. Scutellum without spines. Apical segments of the abdomen exserted and usually rather ovipositor-like in the female .. .. Tribe *Chiromyzini* 3

Mouth parts normal, not situated on a tubercle nor is the face sunken. Scutellum always with spines in Australian forms, but absent in *Allognosta* and perhaps other non-Australian forms. .. .. Tribe *Beridini*.

Key to genera and species of the Chiromyzini.

3. Sexes dimorphic with regard to colour, the head of the female red, thorax and abdomen black; the male brown, eyes contiguous. First tarsal segment of posterior legs twice the length of the second and three-fifths that of the tibia .. .. gen. *Metoponia* 4
   Sexes similar in colour, head never red. One species with a metallic thorax 5
4. First antennal segment about four times the length of the second .. .. *rubriceps* Macq.
   First antennal segment only a little longer than the second .. .. *gemina* Hardy.
5. Female apterous or with vestigial wings. Eyes in the male separate .. .. gen. *Boreoides* 6
   Female never apterous, wings fully developed .. .. gen. *Chiromysa* 7
6. Female with vestigial wings. Discal cell of male open. In male the first segment of the posterior tarsi about as long as the tibia .. .. *tasmaniensis* Bezzi.
   Female entirely apterous. Discal cell of male closed. In male the first segment of the posterior tarsi two-thirds the length of the tibia .. .. *subulatus* Hardy.
7. Eyes very widely separated in the male and more hairy than usual. Thorax metallic. Third segment of the antennae very swollen .. .. *grandicornis* Hardy.
   Eyes of male approximate, contiguous, or, if separated, never with a swollen third antennal segment. Never metallic 8
8. Antennae with the third segment swollen, rather long. Eyes in the male approximate for a short distance .. .. *longicornis*, n.sp.
   Antennae with the third segment more or less conical, with or without traces of annulations 9
9. Eyes in the male separated. First tarsal segment of posterior legs in female two-thirds, in male about half the length of the tibia .. .. *australis* Macq.
   Eyes in the male contiguous or approximating for a long distance 10
10. Hind tarsi of male considerably swollen. First tarsal segment in male about three-fifths, in female two-thirds the length of the tibia .. .. *prisca* Walk.
    Hind tarsi of male ordinary, slender 11
11. Third antennal segment in female containing two conspicuous annulations. First segment of posterior tarsi in both sexes two-thirds the length of the tibia .. .. *stemmaticalis* Enderl.
    Third antennal segment more or less obscurely marked with more than two annulations 12
12. Hind tarsi with first segment two-thirds the length of the tibia in female and about half in male .. ..*matruelis* Enderl.
    Hind tarsi with first segment four-fifths the length of the tibia in female, and less than two-thirds in male .. *ava* Enderl.

Genus METOPONIA Macquart.

Macquart, Dipt. Exot. suppl. 2, 1847, 28; Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 54; Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 181.

Character.—Both sexes of both species have the proportions of the posterior legs identical, namely the first tarsal joint is twice the length of the second and three-fifths that of the tibia.

METOPONIA RUBRICEPS Macquart.

Macquart, Dipt. Exot. suppl. 2, 1847, Pl. i., fig. 4; Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 534, Pl. xxix., figs. 5 and 6; Irwin-Smith, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 505-530, Pl. xxvii. and xxviii., 23 text-figs.; xlvi., 1921, 252-255, 8 text-figs.; xlviii., 1923, 49-81, 50 text-figs.; Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 181.

Hab.—Enderlein adds Adelaide to the distribution of this species, therefore it is now known to range from Queensland to South Australia.

METOPONIA GEMINA Hardy.

Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 535, Pl. xxix., figs. 1-4.

Hab.—South Australia must be added to the distribution. A female in Dr. Ferguson's collection, from Adelaide, collected by A. H. Elston, agrees fairly well with this species.

Genus BOREOIDES Hardy.

Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 539.—*Psegmoptera* Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 177.

There can be little doubt concerning the above synonymy, as Enderlein's characters agree with those of *Boreoides*, and the typical species in each case is undoubtedly identical.

The families in which various Australian entomologists have placed the species of *Boreoides* in collections are very wide. Bezzi records that specimens were sent to Dr. C. P. Alexander as Tipulidae. Another position was that of a female of a species of Apioceridae, and it was so placed under the conviction that it was captured *in cop.* with one of that family. The MS. name *Boreomyia* was responsible for its position as an Empid: Coquillet published the name *Boreomyia* for *Boreodromyia*, and the misprint was copied into Aldrich's catalogue, in which was found a generic name the same as that of Walker's MS.

BOREOIDES SUBULATUS Hardy.

Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 540, Pl. xxx., f. 17-22.—*Psegmoptera aurifrons* Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 178.

There can be little doubt regarding the above synonymy. Enderlein's description comes well within the variations of the species as at present recognised.

The first segment of the posterior tarsi is one and two-fifths the length of the second and two-thirds that of the tibia on the holotype female. The allotype male is damaged, but a paratype shows the proportions to be twice and about two-thirds respectively.

BOREOIDES MACHILIFORMIS Enderlein.

Psegmoptera machiliformis Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 178.

The determination of the specific identity of this, the second of Enderlein's species, is left till more material from Adelaide, the type locality, becomes avail-

able for study. It will be observed that Enderlein had only two specimens of the genus under consideration, and the species is very variable in size, coloration and other characters. Moreover, all Australian specimens examined by me show that the proportional lengths of the segments on the posterior legs are similar, and some of these specimens show greater differences in other respects than has been indicated in Enderlein's descriptions. Despite these differences, I have been unable to establish a second species, owing to gradations between the various forms. The amount of pubescence and its colour on the front, and also the distinctness of the median longitudinal furrow on the thorax (two of Enderlein's chief differences) are most certainly variable characters that cannot be used for specific determination.

BOREOIDES TASMANIENSIS Bezzi.

Bezzi, Ann. Mag. Nat. Hist. (9), ix., 1922, 323-328, fig.

Male.—Cubital vein forked, the vein that should close the discal cell not indicated, first and second postical veins branched, third postical absent. First tarsal segment of the posterior legs two and one-third times the length of the second and about as long as the tibia; the proportions on the female are two and one-fourth, and two-thirds respectively.

Bezzi divided the Tasmanian female specimens from those of the mainland, chiefly on account of their possession of vestigial wings, a character borne out by a re-examination of that specimen collected by C. E. Cole near Hobart and referred to in my previous paper. A male from Mt. Wellington undoubtedly belongs to this genus and species.

Hab.—Tasmania. One male allotype, Mt. Wellington, 5.1.18 and a female, Hobart, both taken by C. E. Cole, are in the National Museum, Melbourne.

Genus CHIROMYZA Wiedemann.

Wiedemann, Nova Dipt. Gen., 1820, 19; Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 536.—*Archimyza* Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 157.—*Stenimas* Enderlein, *ibid.*, 175.—*Hylorops* Enderlein, *ibid.*, p. 179.

Despite the fact that Enderlein would place the species known to him in different subfamilies and tribes, all his genera contain species very closely allied and undoubtedly congeneric.

All the species described below, except the first two, conform to the definition given in my previous paper. Of those two, the second is described as being a form intermediate between the first and the more typical species of *Chiromyza*. Into this now complex group come all species of the Chiromyzini in which the females are provided with fully developed wings and the head is not red.

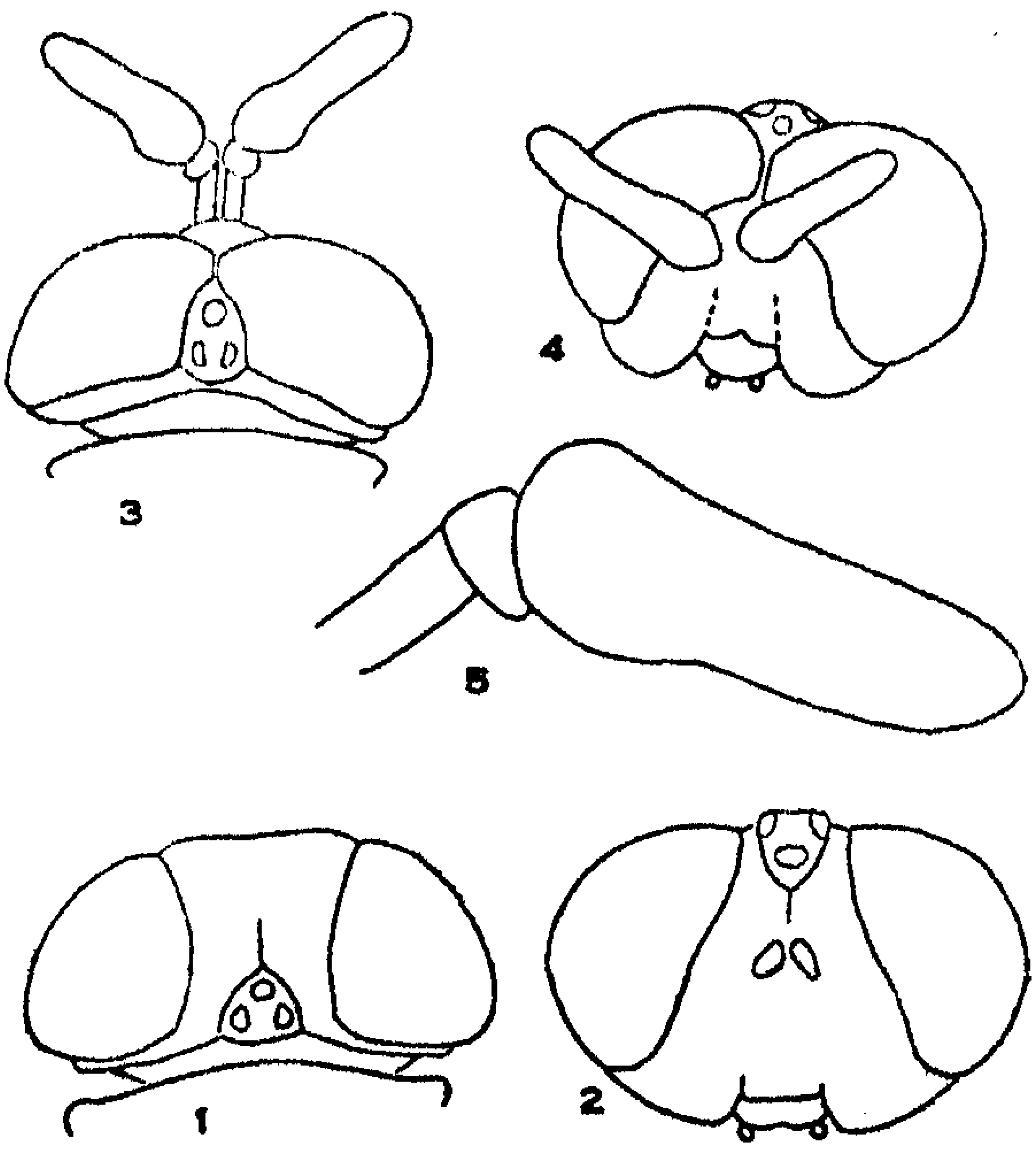
(*C. grandicornis* and *C. longicornis* are appended here, as it is assumed that the unknown female of each species has the wings developed. That both could be separated from all other species of *Chiromyza* on account of the nature of the antennae is recognised, but the following objections render such treatment inadvisable:—(1) The females are unknown; (2) The two species are probably not congeneric, as they differ from each other in every respect but the nature of the third antennal segment; (3) Many allied genera have been proposed during recent years and there is nothing to indicate that, when these are defined on a more satisfactory system than at present, one or more of them will not become available for one or both species under discussion).

CHIROMYZA GRANDICORNIS Hardy. (Figs. 1, 2).

Xenomorpha grandicornis Hardy, Proc. Roy. Soc. Tasmania, 1920, 39, f. 3; Proc. Linn. Soc. N.S. Wales, xlv., 1920, 539.

Male.—Agreeing with the genus *Barbiellinia* Bezzi, in respect to the broadly separated eyes, which are more hairy than in the typical *Chiromyza*, this species disagrees with characters given for that genus in every other respect.

In the original description it is stated that the face "does not recede as" in *C. australis,* which should have read "recedes to a less extent than"; this character makes the tubercle on which the mouth is situated also less marked, though definitely present.



Figs. 1, 2. *Chiromyza grandicornis* Hardy, male.
1. Head seen dorsally; 2. Head, anterior view.
Figs. 3-5. *Chiromyza longicornis*, n.sp., male.
3. Head seen dorsally; 4. Head, anterior view; 5. Antenna.

The first segment of the posterior tarsi is about three times the length of the second and over one-third that of the tibiae.

Unfortunately since the unique type was originally described, both of the antennae have been lost; a diagram was given when the description was made and here further figures of the head are added.

CHIROMYZA LONGICORNIS, n.sp. (Figs. 3-5).

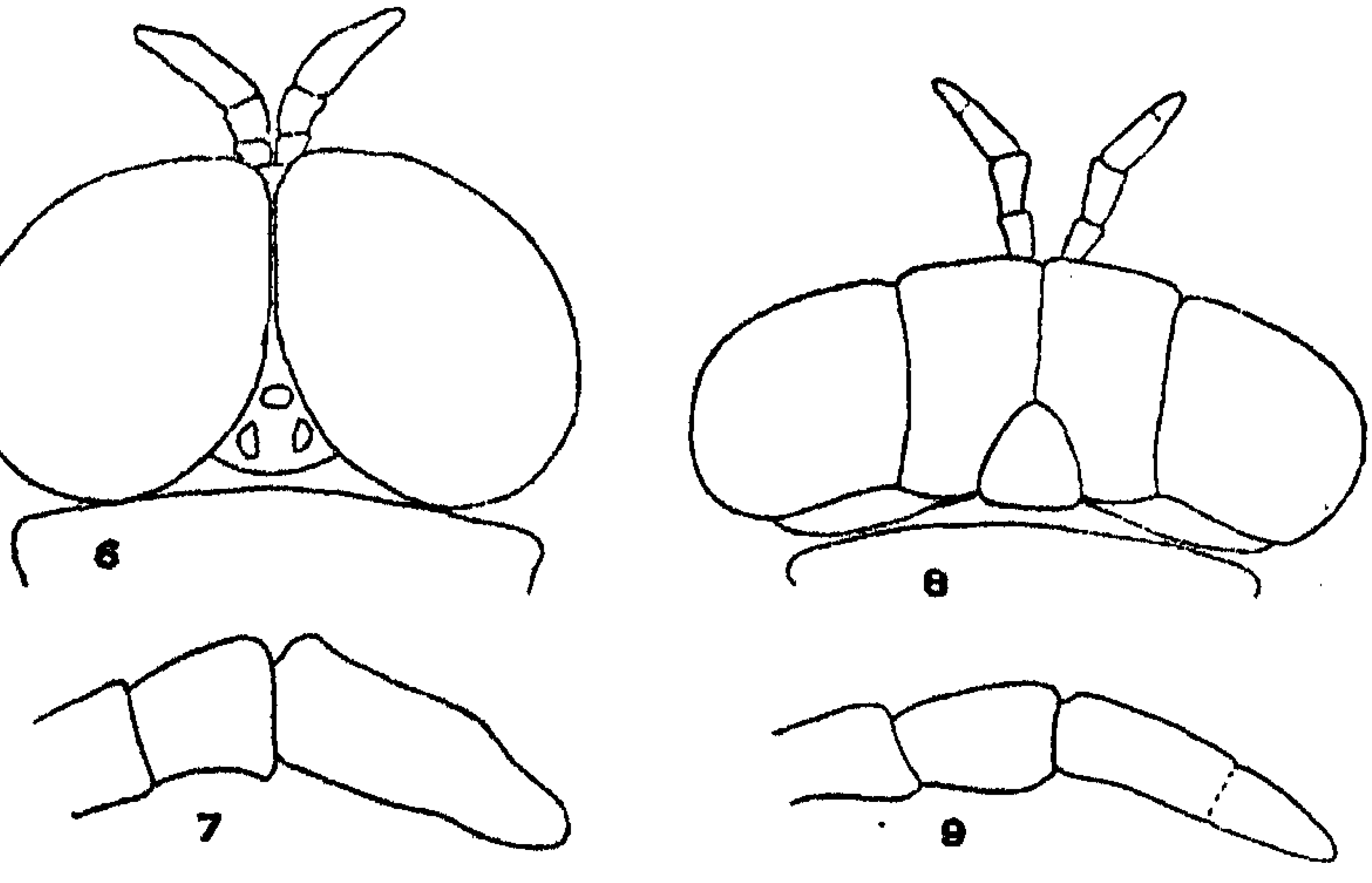
Male.—Eyes very sparsely pubescent, contiguous for a short distance near ocelli, then separating abruptly well above the antennae. Antennae rather long, second segment half the length of the first, and the third, like that of *C. grandi-*

cornis, swollen, without annulations and more than twice the length of the two basal ones united. The colour agrees with that of the typical form of the genus and the markings of the thorax are indicated. In all three specimens examined the upper branch of the cubital fork is present and the third postical vein is absent. First segment of the posterior tarsi twice the length of the second and three-fifths that of the tibiae. *Length*: ♂. 6 mm.

Hab.—Queensland, National Park, March, 1921. Holotype and two paratype males. Although searched for, the females were not discovered; two other species, both males, were found, one being *C. stemmaticalis*, the other a new form referred to under *C. australis*.

CHIROMYZA AUSTRALIS Macquart.

Xenomorpha australis Macquart, Dipt. Exot. suppl. 4, 1850, 54, Pl. iii., f. 7.—*Chiromyza australis* Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 538, Pl. xxx., f. 12-16.—*Hylorops australis* Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 180.



Figs. 6-9. *Chiromyza stemmaticalis* Enderlein.
6. Head of male; 7. Antenna of male; 8. Head of female; 9. Antenna of female.

Macquart described both sexes under the name *Xenomorpha australis*, and, although I believe the females identified by me are identical with Macquart's, the males do not conform to the original description. The thick posterior tarsi referred to by Macquart occur on a male found in the National Park, Queensland, and also on another from Blackheath, N.S.W., but in neither of these are the eyes separate as recorded by Macquart.

Bigot's description of the female of *C. vicina* also seems to apply to the females referred here, as at least one of the specimens described agrees in the main colour markings given for that species, and is the only species so far examined having the central stripe of the thorax divided, making two central stripes with two large trapezoidal spots on each side. The remainder of the insect also agrees fairly well with Bigot's description.

The first segment of the posterior tarsi is twice the length of the second and more than one-half that of the tibiae in the male, whilst the proportions in the female are two and a half times, and two-thirds respectively.

CHIROMYZA STEMMATICALIS Enderlein. (Figs. 6-9).

Stenimas stemmaticalis Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 175.

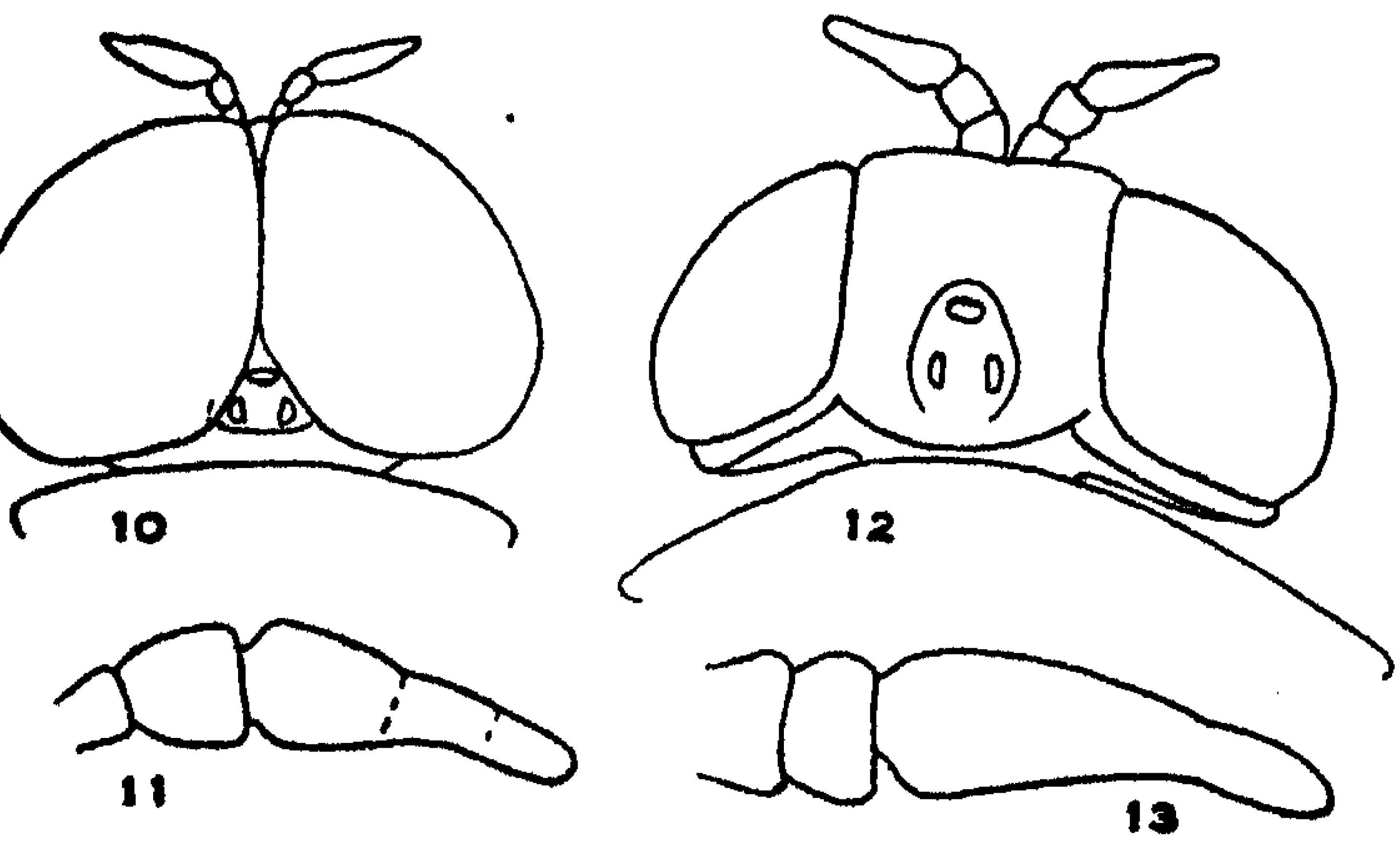
Male.—Eyes approximate for a long distance. Upper branch of the cubital vein absent in all the males, but present in the female; third postical vein strongly indicated; antennae very short, third segment very little longer than the two basal ones united. First segment of the posterior tarsi slightly more than two and a half times the length of the second and two-thirds that of the tibiae; in the female these proportions are slightly less than two, and two-thirds respectively.

Hab.—Queensland. In the Queensland Museum there are three paratype males and one female taken in the National Park, Dec., 1921, by H. Hacker. A male from the same locality, Mar., 1921, taken by myself, is chosen for the allotype of this species.

CHIROMYZA MATRUELIS Enderlein. (Figs. 10-13).

Hylorops matruelis Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 180.

Enderlein does not give a locality for this species other than "Australia,"



Figs. 10-13. *Chiromyza matruelis* Enderlein.
10. Head of male; 11. Antenna of male; 12. Head of female; 13. Antenna of female.

but his description refers to a dark brown median line on the central stripe of the thorax. This character appears to be unique in the female of the species here described under Enderlein's name.

Male.—Eyes contiguous near ocelli, approximate near antennae; very sparsely pubescent. Antennae rather long, first segment short, the second about the same length but much broader, the third tapering to a black apex and with at least six obscure annulations. Thorax with one median and two lateral stripes discernible. Posterior tarsi with very slight indications of the swollen character found in the males of *C. prisca;* the first segment twice the length of the second and about half the length of the tibiae. The wings have the upper branch of the

cubital vein present, the third postical vein absent. The colour is the typical yellowish-brown.

Female.—Eyes widely separated, posterior tarsi with the first segment two and one-third times the length of the second and two-thirds that of the tibiae. The upper branch of the cubital vein is absent. Other characters as in the male. *Length*: Male 8 mm., female 15 mm.

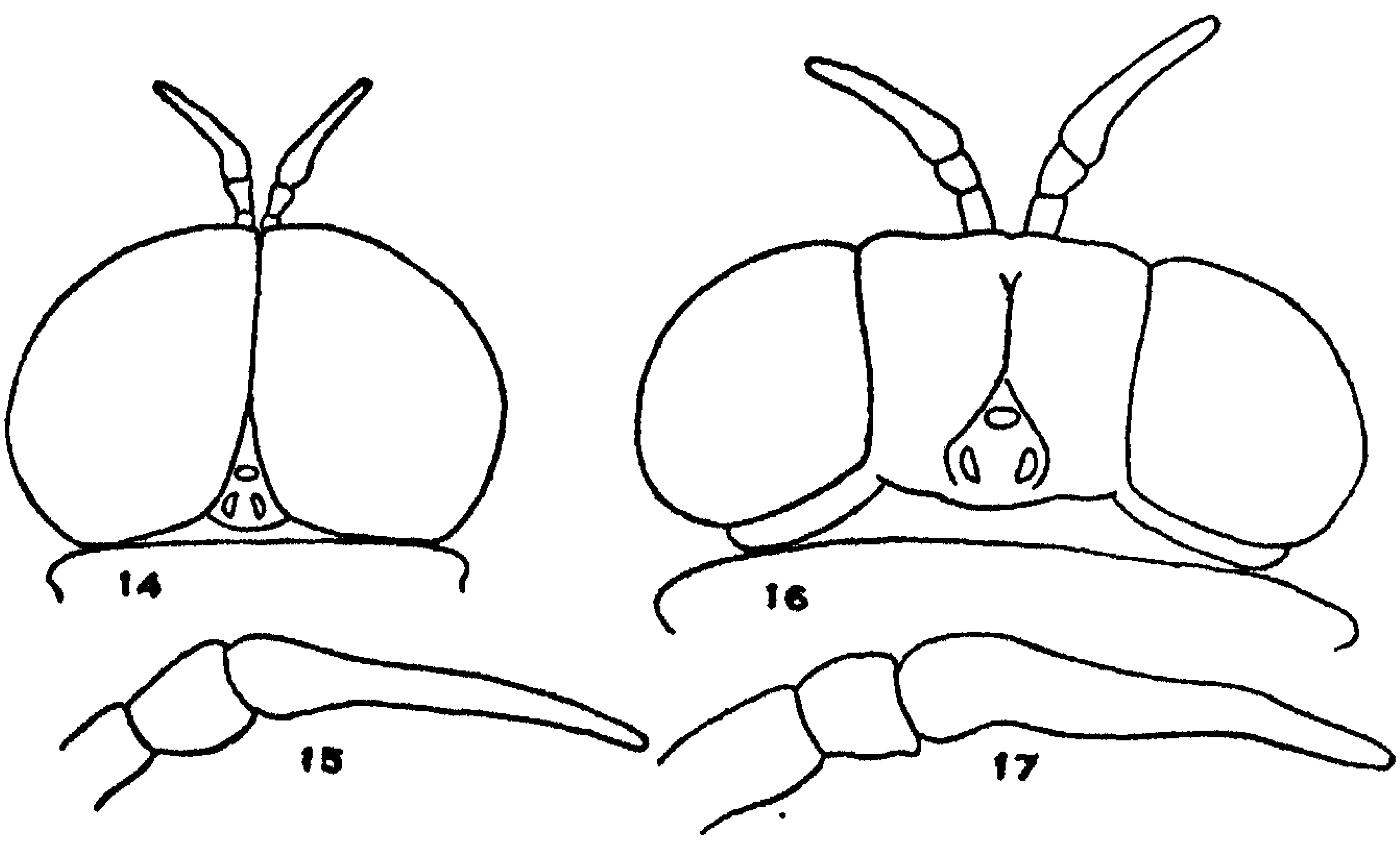
Hab.—South Australia: Mt. Lofty, Mylor, April and May, 1921, collected by Mr. John Formby.

Types.—Male allotype and one female in my collection; three paratype males and four females in that of Dr. Ferguson; these specimens were originally sent to Dr. Ferguson by Mr. G. H. Dutton. One female in the Australian Museum.

CHIROMYZA AVA Enderlein. (Figs. 14-17).

Archimyza ava Enderlein, Mitt. Zool. Mus. Berl., x., 1921, 157.

Eyes in the male contiguous for a long distance. Third segment of the an-



Figs. 14-17. *Chiromyza ava* Enderlein.
14. Head of male; 15. Antenna of male; 16. Head of female; 17. Antenna of female.

tennae longer than the two basal ones united and conspicuously annulated; six annulations are definitely present. Upper branch of the cubital vein present in all specimens examined, the third postical vein absent or indicated by a stump. The first segment of the posterior tarsi in the male is one and two-thirds the length of the second and less than two-thirds that of the tibiae; in the female these proportions are two and a quarter, and more than four-fifths respectively. There is a slight tendency towards the formation of the male tarsi referred to as swollen, found on *C. prisca*.

Hab.—Queensland. Tambourine Mt., April, 1911. (H. Hacker).

Types.—Allotype male and six male paratypes, together with two females, in the Queensland Museum.

CHIROMYZA PRISCA Walker.

Walker, Ins. Saund. Dipt., 1852, 162; Hardy, Proc. Linn. Soc. N.S. Wales, xlv., 1920, 539, Pl. xxix., f. 7-11.

The first segment of the posterior tarsi in the male is twice the length of the second and three-fifths that of the tibiae; in the female these proportions are one and four-fifths, and two-thirds respectively.

Literature dealing with Australian Chiromyzini.

BEZZI.—*Ann. Mag. Nat. Hist.* (9), ix., 1922, 321-328. (The first Eremochoetous Dipteron with Vestigial wings).

———. *Ann. Ent. Soc. Amer.*, xv., 1922, 117-124. (On the South American species of the Dipterous genus *Chiromyza* Wied.).

BIGOT.—*Ann. Soc. Ent. France* (5), ix., 1879, 200.

ENDERLEIN.—*Mitt. Zool. Mus. Berlin*, x., 1921, 153-214. (Ueber die phyletisch alteren Stratiomyiiden-subfamilien).

HARDY.—*Proc. Roy. Soc. Tasm.*, 1920, 33-64. (Australian Stratiomyiidae).

———. *Proc. Linn. Soc. N.S. Wales*, xlv., 1920, 532-542. (A revision of the Chiromyzini).

IRWIN-SMITH.—*Proc. Linn. Soc. N.S. Wales*, xlv., 1920, 505-530; xlvi., 1921; 252-5 and 425-452; xlviii., 1923, 49-81. (Dealing with the biology and anatomy of *Metoponia rubriceps* Macq.).

MACQUART.—Diptères exotiques nouveau ou peu connus. Supplements 2 and 4, 1847, 1850.

OSTEN-SACKEN.—Entomologischer Verein. *Berl. Ent. Zeitschr.*, xxvi., 1882; xxvii., 1883.

WALKER.—List Dipt. Brit. Mus., Suppl. 1, 1854.

———. Insecta Saundersiana. i., Diptera. 1850-6.

WHITE.—*Proc. Roy. Soc. Tasm.*, 1914 and 1916.

———. *Proc. Linn. Soc. N.S. Wales*, xli., 1916, 71-100. (A revision of the Stratiomyiidae of Australia).

WIEDEMANN.—Nova Dipterorum Genera, 1820.

———. Aussereuropaische zweiflugelige Insekten, ii., 1830.

WILLISTON.—*Trans. Ent. Soc. Philad.*, xv., 1888, 244.

THE MOTOR NERVE-ENDINGS OF THE LIMB MUSCLES OF THE FROG (*RANA TEMPORARIA*) AND OF THE MUSCLES OF THE PECTORAL FIN OF THE DOG-FISH (*SQUALUS ACANTHIAS*).

By P. D. F. MURRAY, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Plates xxxvii.-xliii.)

[Read 27th August, 1924.]

The material investigated in this paper consisted of two muscles of the limb of the common frog (*Rana temporaria*) and of the muscles of the pectoral fin of *Squalus acanthias*.

The technique was based on the silver impregnation method of Bielschowsky. In the case of the frog, I followed more closely the modification of Agduhr (1917) and in the case of the fish that of Boeke (1913, 1917).

As a counterstain to show up the nuclei, which are usually only very feebly stained in a successful preparation, I have used chiefly Mayer's alum carmine.

In the case of the material from *Squalus* the process was essentially similar, but differed in a few respects.

The material was fixed by Professor Goodrich, to whom I am indebted for permission to use the material, at Plymouth.

The Merits of the Bielschowsky Technique.

The main merit of the Bielschowsky technique is the clarity of the neurofibrils. A sharp black colouring of the nerve-fibres and loops is obtained, which is very much clearer than the less sharp appearance obtained by means of methods using methylene-blue or gold chloride. The knob-like endings to fibres and the varicosities on the course of fibres seen by these methods are seen in Bielschowsky preparations as loops or networks of black stained neurofibrils, while the varicosities of the fibres are seen to be loosenings of the neurofibrils composing the nerve-strand. These advantages are to some extent shared by the Cajal and Golgi methods, but the Bielschowsky method has an advantage over them, in that it is the only technique which has so far revealed the periterminal network of Boeke. The question, whether this is to be regarded as a virtue or a vice, depends on our decision as to the nature of this network, which will be discussed at a later stage.

The most serious defect of the Bielschowsky method is perhaps the difficulty of seeing the medullary sheath and other membranes of the nerve fibre. It certainly seems that the medullary sheath is more clearly seen in gold-chloride preparations than in Bielschowsky preparations. The bearing of this on recent

work by Boeke and Agduhr on the alleged sympathetic innervation of striated muscle is clear. A large part of their work is dependent on the possibility of seeing whether or not a very fine fibre has a medullary sheath. It has always been my experience that the medullary sheath is harder to see the smaller the fibre, and it seems quite possible that the very fine fibres considered by them to be non-medullate may really have a very fine medullary sheath which is not visible in Bielschowsky preparations. On the other hand, the experimental work advanced in support of the sympathetic innervation seems to be conclusive.

It should also be pointed out that the heavy treatment with formalin must have serious shrinkage effects (notice the shrinkage of the nuclei or of the muscle substance, as revealed by their lying in clear spaces, Pl. xli., fig. 16) and this may well be supposed to lead to artefacts. This point will be referred to again in dealing with the periterminal network.

A very serious impediment associated with the use of the Bielschowsky methods is the empirical nature of the process and its very capricious character. Two pieces of the same tissue, or even different regions of the same piece, which have been treated throughout the process in exactly the same way, and which have lain side by side in the same solutions, may show very different results, one being a success, the other a failure.

We shall now proceed to discuss the motor endorgans in the limb muscles of the frog.

The Motor Nerve Endings in the Frog (Rana temporaria).

Owing to the great amount of work that has been done on the motor endings in the frog, it seems unnecessary to describe them in great detail here.

The principal workers in this field have been, among others, Kuhne, Dogiel (1890), Sihler, Cuccati (1888, 1889), Cecherelli (1904), Bremer (1882, 1883), Retzius (1892), etc.

In general, the endings are described as coming from large, coarse, medullated fibres, which branch several times, so forming a brush-like arrangement, the branches themselves branching again several times. After losing the medullary sheath, the axon penetrates under the sarcolemma. The naked axon then runs along as a more or less winding, varicose fibre, which often ends in a large or small expansion. The axon may branch several times, and these branches may branch again, often forming a very complicated end-brush. There is usually no end-plate with a large accumulation of sarcoplasm, forming a definite and restricted locus for the ending, such as occurs in reptiles, birds, and mammals, and which, as we shall see, is approached in *Squalus acanthias*. The ending as a whole is large and diffuse, the spreading terminal and subterminal fibres covering a large area of the muscle fibre. Four endings of this typical form are shown (Pl. xxxvii.; Pl. xxxviii., fig. 4). With this general description I am entirely in accord, and the description is confirmed by my preparations.

Usually these fibres spreading about under the sarcolemma are all that has been seen of the ending, end-loops not having been generally observed. Frequently, however, as may be seen by reference to the figures of earlier authors (e.g., Retzius), these fibres have been seen to end in expansions, and to have given off as branches other very fine, usually short fibres, which likewise end in expansions or knobs. Now, in my preparations, where the fibres can be traced far enough, they become finer and finer, but ultimately one can sometimes see

a very small, hardly visible, loop at the end, and at the ends of very fine branches.

Plate xxxviii., fig. 5, for example, shows the end of a terminal fibre, which breaks up into two exceedingly fine branches, of which one ends in a loop and the other in what appears to be a loop with its end cut off. Plate xxxviii., fig. 6 shows a fibre which ends in an extremely small loop, and two branches, of which one has its ending in some other section, and the other, after bifurcating, goes beyond the sphere of the figure. Plate xxxviii., fig. 7 shows what looks like the ending of a fibre in a polygonal loop. As this loop has somewhat the appearance of the loops which are sometimes met with in the course of a fibre, I am not sure that it really is an ending.

On Pl. xxxviii., fig. 8 is shown a short branch given off laterally from a fairly thick fibre. It forms a rather complicated loop ending, with four little subsidiary loops associated with it. This is rather unusual, other end-loops I have seen being quite simple.

Plate xxxviii., fig. 9 is a simple loop ending of a lateral branch of a rather thick fibre.

The question now arises, are these loops which I see identical with the knobs and expansions of those writers who have used the gold chloride or methylene-blue techniques, or are we to suppose that these authors, by reason of their technique, failed to see the true endings? I think the former is the truth, for, if one examines their figures, those, for instance of Retzius, one is much struck with the resemblance in position and size of their terminal knobs and expansions to my loops.

This raises another question, which of the two pictures is the correct one? It is a question which is at present impossible to settle for certain, but one must bear in mind the fact that the Bielschowsky technique is one which may very well be expected to form artefacts. Formalin is the necessary fixative and is never a very good fixative. Further, the long and complicated treatment with silver nitrate and the ammoniacal solution cannot but tend in the same direction. In view of this, one must admit the considerable possibility of the loops and nets seen in Bielschowsky preparations being artefacts. On the other hand, one must remember the great accuracy and precision of outline, and the constancy of form of these structures. This is not what one would expect in an artefact. Rather one would expect something less precise and less constant in form. It also seems possible that the loops may really be present in methylene-blue and other preparations but may be masked by the stain colouring some other constituent of the ending as well. Thus, while the question must remain open, there is no good reason for definitely regarding the loops and nets seen in Bielschowsky preparations as artefacts. At the same time, one must remember the possibility.

As in other endings, there is a very marked accumulation of nuclei in the region of the muscle fibre involved in the ending (Plate xxxvii; xxxviii., fig. 4). The accumulation of nuclei is very much greater than in other parts of the same muscle fibre. Most of the nuclei are of an oblong form and have their axis of greatest length parallel to the length of the muscle fibre.

Besides this type of ending which has just been described, I have also found in this material another type. The general characteristics of this kind of ending as compared with the previous type, are as follows:—The parent fibre or fibres approaching the muscle fibre are very fine, finer than all but the finest

of the terminal fibres of the coarse type of ending, and nothing can be distinguished of a neurofibrillar structure, except at endings or varicosities. The parent fibres frequently appear to run in groups, four or five fibres together, and all of them may have endings on the same muscle fibre. The parent fibres in the fine type of ending do not undergo the extensive branching into subterminal and terminal branches which we have seen in the endings of the coarse fibres, but may end by simple loops or nets without any branching, or may have little side branches bearing small loops or nets. The fibres forming the endings do not show any particular orientation as regards the length of the muscle fibre, such as we have seen in the terminal branches of the coarse fibres. There is no medullary sheath distinguishable. As we have seen, this is not by any means a proof that it does not exist.

This type of ending is very rare, far rarer than the endings of the coarse fibres. I have only been able to find four cases sufficiently perfect to figure, but I have seen a number of others which cannot be figured on account of imperfect impregnation or some other fault. The fine fibres from which these endings come are common enough sometimes, but it is very difficult to trace them to their terminations, because the smaller the fibre the greater the difficulty experienced in getting it impregnated, and in following it through a series of sections.

I shall now proceed to describe these four endings in turn.

(1). Plate xxxix., fig. 10.—There are four very fine fibres, two slightly thicker than the others. At least three of these figures show clearly points at which they are in connection with the muscle substance.

The points of distinction between this type of ending and the type from the coarse fibres, as indicated above, will all be noticed here. The fibres are very fine, there is no branching, except in one place to form a net-like ending, fibres are not parallel to the length of the muscle fibre, and there is no medullary sheath distinguishable. (This also applies to the very last branches of the other type of ending).

Fibre (*a*) appears to have some sort of end-apparatus at the point (1), but I have not been able to determine the nature of this. Possibly the fibre merely takes a rather sudden twist. From (1), the fibre passes between the two nuclei marked (2) and (3). This can be determined by careful focussing when, on focussing downward, the one nucleus comes into focus, then the nerve fibre, and then the other nucleus. This point is important, as a fibre passing between two nuclei cannot be anything but hypolemmal. The fibre then takes a turn to the left, where it undergoes an expansion (4), in which the neurofibrillar structure becomes visible, but which may or may not be an actual point of functional connection with the muscle fibre. It is noticeable, in this respect, that this expansion occurs in close proximity to a loop of another fibre around which "periterminal network" (see below) and an accumulation of sarcoplasm is visible. Just in the neighbourhood of this expansion the precise relation of this fibre to others is difficult to determine precisely. It appears, however, that this fibre (*a*) continues from the expansion just mentioned, crosses two nuclei, and then, becoming rather thicker, takes a loop turn (5) and ends in a small loop (6). The loop (5) is almost a network as its angle is crossed by several very fine neurofibrillar strands. The final loop (6) is not quite a plain loop, but presents rather the appearance of a loop within a loop. This end apparatus

is situated in an accumulation of granular sarcoplasm, through which the striations of the muscle cannot be traced. This fibre (*a*) is somewhat thicker than fibres (*c*) or (*d*), but is of about the same thickness as (*b*).

Fibre (*b*), as just stated, is of about the same thickness as fibre (*a*).

At the point marked (7) it gives off a side branch which expands into a kind of network in which the neurofibrillar structure becomes visible. This network lies very close to a nucleus and one end of the network actually lies in an indentation of the nucleus. This certainly can be taken as an indication that the position of the network is hypolemmal. Careful focussing reveals that there is, as shown in the figure, a very delicate network in the sarcoplasm, partially surrounding the nerve-net and suggesting that it is some sort of connecting structure between the nerve-net and the sarcoplasm of the muscle fibre. It is very small, and it is difficult to be sure that one is looking at a net work, as it also looks something like a collection of little vesicles. This structure is the periterminal network of Boeke, which will be discussed more in detail later.

From the point (7), where it gives off the side branch to the nerve-network, the fibre proceeds to the point (8), up against the nucleus marked (2). Here it appears to end in a little expansion, which one sees in profile, either quite or very nearly in contact with the nucleus. It is impossible to make out more of this than is shown in the figure. I have not been able to trace the fibre beyond this point.

Fibre (*c*) is thinner than either (*a*) or (*b*), but of about the same thickness as (*d*). This fibre runs across the muscle-fibre to the point (9), where it has a loop. This is not, however, the ending of the fibre, which goes on some distance beyond. The loop is surrounded by an accumulation of sarcoplasm, but is situated eccentrically at the edge of this accumulation. There is some periterminal network on one side of the loop. Beyond this point, the fibre continues for some distance and then disappears.

Fibre (*d*) is of much the same thickness as (*c*). At the point (10) there is a loop, whose connection with the fibre has been cut. Since, however, it has a stalk curving in the direction of the fibre and very nearly reaching it, it seems reasonable to suppose that it is a branch of the fibre. On the side of the loop remote from its stalk there is a small branch coming off from the fibre in the direction of the loop, which suggests that the loop may perhaps have been developed on a collateral branch of the fibre, which, having formed the loop, immediately joined the fibre again. The loop is not quite a simple loop, as it has a fine neurofibrillar strand crossing it.

From this point the fibre continues to the point marked (11), where it appears to be in connection with the small somewhat thick-walled loop at this point. Its fate subsequently to this is hard to determine; it appears to join fibre (*c*), but of this I am very doubtful indeed. The relation of this fibre to the net-like expansion on fibre (*a*) is also difficult to determine, but I do not think it is in any way connected with it.

The general orientation of the nuclei is for them to have their long axes parallel to the long axis of the muscle fibre.

An idea of the size of the fibre forming this ending, as compared with those forming the larger type of ending, can be attained by comparing the

fibres concerned in the ending with the large thick fibres running in the nerve bundle between the muscle fibres, from which these thin fibres are derived.

(2). Plate **xxxix.**, fig. 11.—This figure shows five very fine fibres, of which two have end-loops, while at one point there is a periterminal network. Fibre (*a*) leads to the tiny loop at the point (1). Fibre (*b*) leads to the larger loop at the point (2). The fibre (*c*) leads to a position very close to the loop at (1), and is here in some way concerned with some periterminal network. The remaining two fibres have no ending in the preparation.

There is an accumulation of some seven nuclei round the actual positions of the ending and several others at the edge of the muscle fibre. The orientation is, as usual, roughly parallel to the length of the muscle fibre.

(3). Plate **xl.**, **fig.** 12.—In this figure we see a doubtful number of very fine fibres, doubtful because unfortunately the ending is not a complete one and some of the strands of fibre seen are possibly pieces of one fibre which has been cut more than once. There are some six very small loop endings, of which at least two are not final end-loops as the fibre continues on beyond them. One of these two is broken, and so we cannot be certain that it is really a loop at all, it may have been a branch. The three terminal loops are simple loops, not having any cross fibrils or other complications. One of them (1) seems to have at one side of it a very slight development of periterminal network. The broken loop is not so simple, having two cross bars.

At (2), (3), and (4), there are three rather peculiar net formations consisting apparently of neurofibrillar expansions of fibres which, beyond the networks, continue on again as ordinary fibres. There is periterminal network on both sides of (3), but especially on one side, as shown in the figure.

As usual, there is an accumulation of nuclei whose orientation is only very roughly parallel to the length of the muscle fibre, and there are a number of small nuclei at the edge of the muscle fibre.

Plate xl., fig. 13.—In this figure we see what appears to be a single fibre which, leaving a small nerve group at the base of the picture, goes to the neighbourhood of a small group of nuclei at the top. Here it turns through 90 degrees, forms three loops, turns through 90 degrees again, and returns to the nerve bundle. At the top left hand corner there is a very complicated series of fibrils, which twist and turn so as to make it impossible to determine with precision the nature of their relations to the main fibre.

There is a certain amount of periterminal network just beneath this area and rather more above the right hand angle of the main fibre (point X). It is very clear in this area and fades away into the substance of the muscle fibre.

At the base of the figure there is a nerve bundle containing some fibres of the coarse type. A comparison of the relative size of the two fibres will show the striking difference between them.

Discussion of the nature of these fine fibres.

The question now arises, what is the nature of these fine fibres which form endorgans of the type just described?

There are two possibilities which must first be settled. They may be motor or they may be sensory.

It may be said at once, that it is impossible to say whether any nerve-

ending is motor or sensory until experiments have been made. In the absence of experiments, however, one can, by a study of certain histological points, reach a conclusion with a considerable degree of probability in favour of its correctness.

The most helpful point here is a determination of the position of the endorgan with regard to the sarcolemma. It seems to be generally accepted, though I am not aware that it has been experimentally proved, that motor endorgans are hypolemmal and sensory epilemmal. Since it is known that both epilemmal and hypolemmal end-organs exist, one would certainly expect the former to be sensory and the latter motor. There seems to be every reason why a motor nerve should be in close and intimate contact with the substance of the muscle fibre, while a sensory nerve, if it required to be informed of nothing but the degree of contraction of the muscle fibre, might well be efficient if merely in close contact with the surface of the muscle fibre. It must be admitted, however, that this line of reasoning is not sufficiently trustworthy to give any certainty. It will remain impossible without experimental proof to say, with certainty, whether any given nerve-ending is sensory or motor, until it has been established without doubt that motor nerve-endings are always hypolemmal and sensory nerve-endings always epilemmal. It is therefore necessary, before we can form any opinion as to whether these endings are sensory or motor, to decide whether they are epilemmal or hypolemmal.

In the first one described (Pl. xxxix., fig. 10) we have seen that it is undoubtedly hypolemmal. As regards the other three (Pl. xxxix., fig. 11; xl., figs. 12, 13) we have seen that all have periterminal network in very close relation to some part of the ending. Now, whether the periterminal network be artefact or not, there is no doubt that it lies in the sarcoplasm. There is also no doubt that it is in the closest connection with the ending. The presence of periterminal network may, therefore, be taken as showing that the ending having it is hypolemmal.

We, therefore, come to the provisional conclusion that these endings are of a motor nature.

Having settled that they are probably motor, we have to decide a further question:—Are they fibres of the same morphological and physiological series as the coarse fibres described first, or do they belong to the accessory (sympathetic) innervation demonstrated, experimentally, to exist in mammals by Boeke (1910, 1911, 1912, 1913, 1917) and Agduhr (1919, 1920)?

Here again we are faced with a question which we cannot settle, for certain, without experiments. It may be that these fibres do belong to this accessory innervation, but it is quite impossible to get any more purely histological evidence bearing in favour of this conclusion in the frog (and the same applies to reptiles and birds) because of the known existence of non-medullate, very fine, branches of ordinary medullate coarse motor fibres (Bremer, 1882, 1883; Retzius, 1892; Ceccherelli, 1904). It is at least equally as probable that the fibres we are discussing belong to this series of branches of ordinary motor fibres, as that they belong to the accessory series known to exist in the mammal. In favour of the latter conclusion is the fact, that I have occasionally noticed fibres and endings which appeared to be more or less intermediate between the coarse type and the fine type. Provisionally, then, these fine fibres must be re-

garded as motor, and as perhaps being branches of the ordinary motor fibres, while remembering that they may possibly belong to the sympathetic supply.

The Motor Nerve-endings in the Pectoral Fin of Squalus acanthias.

Previous work.—Very little work has been done on nerve-endings in fish. Of the papers which I have been able to discover, the most important is perhaps that of Retzius (1892), who has described the motor nerve-endings of *Raja clavata* and *Acanthias vulgaris* (*Squalus acanthias*), using the methylene-blue method. In both he found that the motor fibres were very coarse. In *R. clavata* the nerve fibres gave off branches which formed a brush-like ending of varying complexity on the muscle fibre, and these endings usually had a more or less definite and restricted locus, somewhat like that of a mammalian ending, but some were more elongate and straggling like those in the frog. The fibres forming the ending usually had terminal discs at their ends, but in some cases the endings of the fibres were in the form of bands. *Acanthias vulgaris* was similar to this, but the endings were simpler, i.e., the branching was less complicated.

Poloumordwinoff (1899) described sensory endings, which, he says, consist of a great number of fine varicose fibrils lying on the sarcolemma (epilemmal). Each fibril ended in a little swelling. He described the sheath of Henle as enveloping the ending and, beyond it, joining the sarcolemma. He agrees that the endings have a definite locus, not being spread about the muscle fibre like those of a frog.

Cavalié (1902), using *Torpedo marmorata*, gave a method for distinguishing between motor and sensory fibres. According to him, in a sensory ending, the striations of the muscle are visible beneath the ending itself, while in a motor ending, they are not. Unless I have never seen a sensory ending in *Squalus* (which is quite possible), this criterion is not effective in Bielschowsky preparations. Since the material is in section, one is not looking at the surface of the muscle fibre, but at a section of it, and the slightest change of focus will show striations. On the other hand, I have frequently found it difficult or impossible to see striation at all, either beneath the ending or anywhere else. In the figures, I have usually omitted the striations over the greater part of the figure for the sake of clearness, while including it over a small area for the sake of comparison of its size with that of the ending.

As regards the form of the motor ending, Cavalié is in agreement with Retzius and Poloumordwinoff. He describes the fibre as losing its myelin, and then making a "pseudo-plate" rich in nuclei, having formed five, six, seven or more branches. The fibrils end in little swellings which he describes as having frilled extremities, suggesting that perhaps he just missed seeing the periterminal network. He called this type of ending "Terminaison en ombelle."

There is also a paper by Belousov (1909), in Russian. It concerns Teleosts.

Comparison of the Endings of Squalus *with those in the Frog.*

With the description quoted above, I find myself in agreement in most respects, except that the endings I have observed seem generally to have a smaller number of terminal branches than those of the earlier authors. This may very possibly be due to the fact that my preparations are in section, and so one

does not always get a whole ending on one section. One ending I have seen extended over at least three sections.

The main distinction between the endings I have found in the pectoral fin muscles of *Squalus* and those above described in the frog is that the endings in the case of the fish are confined to a very much smaller area of the muscle fibre than is the case with the frog. In the frog, as we have seen, the endings do not lie in small and definitely outlined end-plates, as they do in the mammal, in a heap of accumulated sarcoplasm, but are scattered over the muscle fibre as a series of fibres having very small terminal loops, etc., with only a very small sarcoplasm accumulation, or perhaps none. In the fish, on the other hand, the form of the ending is very much more like that in a mammal. The end ramification is restricted to a small area, and, if the impossibility of seeing striations is any criterion, there is a fairly large accumulation of sarcoplasm. But this point must remain uncertain as the sarcoplasm accumulation is nothing like as clear as it is in the mammal. There is, however, a definite restricted end-plate, absent in the frog, but present in the mammal.

Another distinction from the endings I have studied in the frog is the much coarser character of the end-loops and end-nets, and of the terminal fibres. A comparison of the figures will show this.

The form of these nerve-endings will be best understood by a description of a particular case, e.g., Pl. xl., fig. 14.—The nerve fibre, as it approaches the muscle, is very coarse and its neurofibrillar structure is clearly visible. It is contained in a colourless sheath (X), which is only visible in its outline. The nature of this sheath is very difficult to determine, as remarked in the discussion of the merits of this technique. At the point marked (Y) the fibre becomes more compact, the stain is jet-black, and it is impossible to see the neurofibrils. Here the fibre branches into two and each fibre branches again, and then these branches give off several fine side branches. The main branches also divide again several times.

At the ends of the fine side branches are a number of examples of the actual method of termination of these fibres. These terminations are difficult to describe in words, and a reference to the figures is the best description. The general plan is that of the loop, but the form varies from the simple, uncomplicated loop (Pl. xl., fig. 14 at Z) to the complicated networks seen on Pl. xlii., fig. 18. The form is often bizarre in the extreme. The various forms will be best understood by references to figures 14 to 23 (Pl. xl.-xliii.). These end-plates are not necessarily at the terminations of fibres, as is shown in figures 16 (Pl. xli.) and 20 (Pl. xliii.), both of which are from short branches of fibres which appear to continue on elsewhere.

The Periterminal Structure.

The most interesting outcome of the investigation of these endings has been the discovery of a complicated structure or series of structures, more or less corresponding to the periterminal network of Boeke.

Plate xli., fig. 16 shows a nerve-ending (unfortunately not complete) in which there are several terminal loops or nets, and in which there is a very prominent network, apparently consisting of fine fibrils, surrounding the terminal nervous loops, especially in the area designated (X). This network has meshes of much larger and coarser dimensions than those, described above, in

the frog. I have not been able to detect any particular relation between this network and the striations of the muscle fibres, although it seemed to me that the network and the striation were in continuity. This was clearer on Pl. xli., fig. 15 at (X). It is, however, very doubtful.

As regards the relation between this network and the end-loops, there appears to be a definite and perhaps important divergence from the condition described by Boeke, Agduhr, and others for the periterminal network in the mammal. In the mammal, according to these workers, the meshes of the network start from the end-loops and nets of the nerve. In the fish, on the other hand, I seem generally to find that the end-loop lies within the meshes, merely surrounded by them, as shown on Pl. xli., fig. 16. Sometimes, on the other hand, as at the point (Y) on Pl. xli., fig. 15, a fine branch of the nerve seems to be actually continued into the mesh of the network, so that in this case. and in a few others where it shows less clearly, the network and the nerve itself seem to be quite continuous with one another.

This structure has been described above as a network. In some cases the appearance is really more that of a collection of vesicles, of a spherical shape, which, being in section, look like a network. This is especially so at the two points A and B (Pl. xli., fig. 15). I have been quite unable to decide which it really is.

The appearance of a sphere is somewhat heightened by such appearances as that at Z (Pl. xli., fig. 15), where a fibre seems to break up into a brush of fibrils which run out over the sphere.

There is another type of "network," shown in figures 17 and 18 (Pl. xlii.). In figure 17 (Pl. xlii.) there is to be seen around the endings, especially around certain very fine fibrils which seem merely to fade away into invisibility, without loops or nets, a network of much smaller mesh than that last described in figures 15 and 16 (Pl. xli.), but much more resembling that described in figures 10, 11 and 13 (Pl. xxxix. and xl.), of the finer type of ending in the frog. In this case, the appearance of an accumulation of little spheres is still greater than in figures 15 and 16 (Pl. xli.). Once again, however, it is quite impossible to be sure which is the true interpretation. Somewhat against the theory of spheres is the appearance in figure 15 at (C), where three strands of network seem to pass off into the sarcoplasm, without completion of the mesh, one side remaining open. It will be remembered that the network in the frog (Pl. xxxix.; xl., figs. 12, 13) also suggests an accumulation of spheres.

There is another appearance frequently seen, as in figures 16 (Y), 17 (X), 18 (X), 19 (X), 22 (everywhere). Here, in the absence of any periterminal network or other similar structure, the end-loop or net appears to be contained in a little sac, which seems to arise at the base of the individual end-loop or net and completely to enclose it. This sac is very like a single mesh of the coarse type of periterminal network. It will be remembered that the end-loop is usually enclosed within a mesh of this network, just as the end-loop is enclosed in the sac-like structure under discussion. This suggests that the latter is perhaps the same thing as that mesh of the coarse type of periterminal network which encloses the end-loop, but that the remainder of the network is either undeveloped or unstained. This is a point on which light would be thrown by the discovery of conditions intermediate between the two. I have not seen any very satisfactory intermediate condition, but figures 19 and 20 seem to

show something of the kind. In figure 19 at (X) are seen small aggregations of several loops resembling the meshes of the coarse type of periterminal network, but not involving a sufficient number of loops to warrant their inclusion under that title. Individual loops of this character enclose the end-organs just like the sac structures described above (figures 16, 17, 18, 19, 22), and these loops are associated with two or three others forming a small aggregation. At (Y) there are a number of these loops or meshes in a row along one side of a fibre. In figure 20 at (X) somewhat similar conditions are to be seen. Whether one is justified in regarding these structures as intermediate between the coarse type of periterminal network and the sac-like structure is hard to say, but it certainly looks very like it.

There remains to be mentioned what appears to be something quite new in this or any other nerve-ending known to me. I have not seen anything like it mentioned in the literature; and I have only seen it in preparations in the two endings to be described.

This structure is to be seen in figures 20, 21 and 23. Beneath some of the end-loops of figure 20 (at Y) and of figure 23 (at X) are to be seen distinct reddish masses with well defined edges, and over this mass can be distinguished very fine fibrils running off from the end-loops, and, further, the surface of this peculiar body can be seen to be reticulate.

In figure 21 the terminal part of the branch (Z) of figure 20 is shown under a higher power. At the point (X) are two end-loops close together, and beneath the two of them is an oblong oval dark body. This body has well defined edges. Radiating out from the end-loops are a number of fine fibrils, and these fibrils run over the surface of this peculiar body. At the point (Y) there is a loop, and beneath it a similar body to that at (X). In this case a distinct reticulum can be seen on the surface of this peculiar body and the reticulum seems to be connected with, and to centre round, the end-loop of the nerve. Similarly, at (Z) there is a small side branch which seems to end in two or three small branches, but without loops, and beneath these branchlets is another example of this same body, and here again there is very delicate network over its surface, arising from the branchlets of the nerve.

The general characteristics of this structure are that it is found apparently beneath the terminal loops or other terminal organs, that it usually has a fairly definite outline, that it appears generally to have a reticulate surface, and that this reticulum seems to be in definite relation to the end-organ. Its form varies fairly considerably and sometimes it lacks the definite outline seen in figure 21. In figure 23 it can be seen at (X). The outlines in this figure are not so sharp as in figure 20 or 21.

Beyond describing the general position and appearance of these structures, nothing can be said beyond pointing out that they somewhat resemble small nuclei, having a somewhat similar colour and granulate-vacuolate texture. If they prove to be nuclei they are certainly a distinct kind from the ordinary nuclei of the ending, being very much smaller, and their close association with the end-organs would strongly suggest some special function connected with the transmission of the stimulus. Somewhat against the hypothesis that they are nuclei is the appearance seen in 20 at (Z'), where the organ extends as a long, more or less oblong mass, along the greater part of the fibril. This would not be a usual shape for a nucleus.

If these organs are not nuclei, it is impossible to suggest what they may be, beyond the obvious conclusion that they are either of nervous or muscular origin,—unless, indeed, they have a quite different origin!

If they are not nuclei, even, perhaps, if they are, one is reminded of the hypothetical substance of Langley and others. Before, however, any trustworthy conclusions can be drawn, a great deal of further investigation will be necessary.

Discussion of these periterminal structures.

The periterminal network was first seen by Boeke (1910, 1911, 1912, 1913, 1916-17), and it is, therefore, generally associated with his name. His descriptions have been confirmed by Ehrlacher, Stefannelli, and Agduhr (1919, 1920).

According to Boeke, who has observed it especially in mammals, but also in reptiles, the periterminal network appears as a very fine network, extending from the end-rings and end-nets out into the sarcoplasm. It is always less strongly coloured than the nerve ending itself, and the transition from one to the other is sometimes sudden, sometimes gradual. This also I can confirm as regards *Squalus* (if the structure I see is identical with the network described by him) for, while in the great number of cases it is easy to say where true nerve tissue ends and periterminal network begins, it is frequently not so easy, and sometimes I have been in doubt as to whether to draw some object as the one or the other. In figure 15 (Pl. xli.) (Y), further, the fibril indicated seems to turn downwards, and its prolongation becomes one of the strands of the network.

Boeke's descriptions and figures clearly indicate a structure having an obvious net formation, with polygonal meshes. As stated above, however, the appearance in my preparations is somewhat like that of a number of spheres or droplets pressed together, while also resembling a network. Of course, droplets or spheres under pressure would assume the appearance of a network, and would be more like a network the closer together they were pressed. It remains, therefore, impossible to say, at least as regards my preparations, which of these two is nearer to the truth.

Boeke finds the network above all in relation to the end nets and loops, but also in relation to the fibrils along their course as they approach their ending. This statement is quite in accord with my experience as regards the coarse type in *Squalus*, but I am not able to confirm it as regards the fine type of ending in the frog. This fact, however, carries no weight in view of the small number of specimens of this type that I have observed. As regards the fine type of network in the fish, I seem to find the network associated rather with fine fibrils, which fade into invisibility, than with the clear end-loops, etc.

An important point of difference between my observations and those of Boeke, as regards at least the coarse type of network in *Squalus*, is that, while he finds a definite connection between the strands of the network and the fibrils of the nerve ending, I find that the end-loops seem rather to be enclosed within the meshes than actually joined to them.

The question as to whether the networks observed by me in the fish and frog are identical with those observed by Boeke is difficult to settle for certain. As regards the frog, however, the resemblance seems sufficiently close to justify a conclusion that they are the same thing, while, as regards *Squalus*, there are

points of difference which cause one to hesitate before arriving at the same conclusion. Nevertheless, when one remembers the striking general resemblances between them, together with the fact that absolute identity is hardly to be expected in such very different animals as fish and mammals, or even fish and reptiles, one seems justified in coming to the same conclusion here too.

The other terminal structure observed in my preparations has already been discussed.

In all discussions of the structures seen after the Bielschowsky treatment there is one important point to remember, the considerable probability of the creation of artefacts. But even if these structures are to some extent artefacts, and although one be forced to admit that the network is not such in life, still the conclusion cannot be avoided, that there is something present in this position which is absent in other parts of the muscle fibre, and that this something is intimately associated with the nerve-ending.

This is not the place for a discussion of the possible physiological significance or embryonic origin of the periterminal network. This has already been discussed by Boeke (see esp. 1911, 1916-17). There are, however, two points brought forward by Boeke which throw some light on the latter problem and which may be mentioned. In the first place, he finds, in preparations of degenerating endings, that the periterminal networks degenerate with the degeneration of the ending and then regenerate when the nerve-endings regenerate. In the second place, when the network is regenerating, it develops first in connection with the nerve-loops, etc., and then spreads out from here through the sarcoplasm. Apparently, then, the network is dependent on the nerve-ending for its continued existence, and develops, at least in regeneration, in close relation with the nerve-ending. Beyond these facts, it is impossible as yet to go.

In conclusion, I have to thank Professor E. S. Goodrich, F.R.S., for suggesting this work to me, and for much helpful advice and criticism while it was in progress. I have also to thank Mr. H. M. Carleton, of Oxford, Professor Da Fano, of Kings College, London, but above all Professor J. Boeke, of Utrecht. During three weeks when I was working in his laboratory at Utrecht, Professor Boeke showed the greatest kindness, allowing me all the facilities in his power, and was most helpful in every way.

SUMMARY.

(1). The ordinary motor nerve-endings of the limb muscles of the frog are described.

(2). Another and very much finer type of nerve-ending of the limb muscles of the frog is described. This may possibly be the accessory (sympathetic) innervation. The periterminal network in connection with these nerve-endings is described, thus showing the existence of this structure in the frog.

(3). The nerve-endings of the pectoral fin of *Squalus acanthias* are described, with two types of periterminal network and another hitherto undescribed structure. The latter is a small mass of some substance found in two cases beneath the terminal loops, etc. The terminal loops appear to give off very fine branches which run over this structure forming a network.

(4). The nature of these periterminal structures is discussed.

(5). Nothing resembling a sympathetic innervation was found in the fish.

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EXPLANATION OF PLATES XXXVII.-XLIII.

Plate xxxvii.

Motor nerve-ending in limb muscle of frog. Coarse type. 1. (x 500); 2. (x 400); 3. (x 500).

Plate xxxviii.

4. Motor nerve-ending in limb muscle of frog. Coarse type. (x 500).

5-7. Termination of nerve fibre. Coarse type of motor nerve-ending in limb muscle of frog. (x 2,300).

8-9. Termination of small branch nerve fibre. Coarse type of motor nerve-ending in limb muscle of frog. (x 2,300).

Plate xxxix.

Motor nerve-ending in limb muscle of frog. Fine type. 10. (x 1,400); 11. (x 2,300).

Plate xl.

12, 13. Motor nerve-ending in limb muscle of frog. Fine type.

14. Motor nerve-ending in muscles of pectoral fin of *Squalus acanthias*.

Plate xli.

15, 16. Motor nerve-ending in muscles of pectoral fin of *Squalus acanthias*. 15. (x 1,500).

Plate xlii.

17-19. Motor nerve-ending in muscles of pectoral fin of *Squalus acanthias*. 17. (x 1,300); 19. (x 1,300).

Plate xliii.

20-23. Motor nerve-ending in muscles of pectoral fin of *Squalus acanthias*. 20. (x 1,450); 21. higher power figure of part of Fig. 20. (x 2,300); 22. (x 1,300); 23. (x 1,300).

STUDIES IN PLANT PIGMENTS.

Part ii.—The Red Pigment induced by Insect Injury in Eucalyptus stricta.

By James M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Biochemistry.

(*From the Physiological Laboratory of the University of Sydney.*)

(Plate xliv.)

[Read 27th August, 1924.]

It is a generally accepted view that among the many brilliant colours of the plant-world there are recognised, chemically, a very few fundamental structures on which the pigments are built up. In the three groups of anthocyanin pigments the compounds forming their chemical basis are predominantly red in colour, and one is naturally led to associate all bright red colours of flowers with the anthocyanin group.

Yet are there to be found at times examples of fine red pigments not associated with flowers at all, nor belonging to the anthocyanins. Such an example was found on the Blue Mountains, near Mt. Victoria, where *Eucalyptus stricta* grows in dense societies in the *Eucalyptus eugenioides* forest of the sandstone plateau. The small trees of *Eucalyptus stricta* varied the uniform green of their foliage by large areas of red coloured leaves. The red coloration presented quite a different appearance from the purple red of the young foliage of the Eucalyptus in general, and was accompanied by extensive fasciation.

A closer examination revealed the fact that these phenomena were due to an injury caused by some insect, whose wide-spread depredations had resulted in the modification of the form of both leaf and twig. In many places the leaves were consumed and the malformation of twigs gave evidence that the cells of the growing tips had been attacked in the meristematic condition. Fusion of parts and also prolific branching of the twigs were observed; all the fasciated organs were coloured bright red; the whole indicated a general interference in the metabolism, and a profound disturbance of the normal growth of the plant.

The insect causing this malformation has been identified by Mr. W. B. Gurney, Government Entomologist, as a new species of microscopic mite, and a note describing it is appended to this paper. The author is greatly indebted to Mr. Gurney for this valuable addition, and for the photograph of the affected foliage (Plate xliv.).

This paper contains (1) an account of the isolation of the pigment from

the red fasciated leaves, and the chemical examination of its properties, (2) a description of some recorded cases of similar phenomena, and (3) a discussion of the physiology and biochemistry of the mechanism of red pigment formation.

EXPERIMENTAL.

The material, consisting of greatly fasciated masses of red leaves, stalks, and short red twigs, weighed 1,300 grams in the air-dried state. This was macerated in alcohol for some weeks, after which it was drained and pressed, and the operations repeated a number of times. The extract consisted of about 7 litres of a very dark red-coloured fluid, which was concentrated under diminished pressure to 1 litre, and allowed to stand for some time to settle. In this way were obtained:—

A. A deep red fluid.

B. A light coloured deposit, which settled quickly, on cooling, as a semi-crystalline mass.

C. A brick-red deposit of phlobaphene, after standing for some days.

Examination of the red liquid A.

(1). A portion of the alcoholic solution was precipitated by the addition of 4 volumes of ether. The bright yellow ethereal solution was distilled and the residue carefully examined for flavones which may have been present in the non-glucosidal state. No flavones were obtained, but the yellow substance, when redissolved and purified with charcoal, was obtained in white crystals. These exhibited the properties and reactions of gallic acid, which was therefore probably present in the tissues of the injured plant.

(2). The whole of the red solution was treated with lead acetate, which deposited a yellowish-brown solid, but left the filtrate still red in colour (7). This red filtrate was not precipitated by the subsequent addition of basic lead acetate.

The brown precipitate, after removing the lead, was submitted to hydrolysis, by boiling for a few hours each day with sulphuric acid until no further deposit formed on standing. This was complete on the fifth day, and the fluid was still of a deep red colour (8).

Since anthocyanins are rendered insoluble under these conditions the deposits were next examined.

These deposits, after separation from the red fluid, weighed 46 grams, and appeared to consist of two different substances—a heavy flaky deposit of an Indian-red colour (3), weighing 33 grams, and a fine amorphous yellowish powder (4), weighing 13 grams. The separation of these was readily accomplished by washing with water and decanting the light yellow powder.

Examination of the indian-red deposit obtained by hydrolysing the red fluid.

(3). Just 50% of this substance was soluble in alcohol, the insoluble portion being reserved (5).

The concentrated alcoholic solution was very bright red in colour; on standing a few days a light grey substance separated, which possessed properties similar to deposit B obtained at the beginning. The red fluid was poured into a large volume of ether, from which there soon separated a bulky precipitate of a purple-brown colour. This substance was repeatedly purified and dried;

after which its properties were studied in detail. The ethereal fluids were reserved (6).

Properties of the red pigment.

The substance was in the form of dark red flakes, and even after slow evaporation was entirely devoid of crystalline form. When warmed with water, or dilute hydrochloric acid, the substance was quite insoluble, but dissolved rapidly and completely in water with a drop of ammonia, forming a red liquid. It was also soluble in alcohol to a red solution. When poured into a large volume of water this alcoholic solution was not precipitated, but on the addition of a drop of acid instant precipitation occurred, as a buff coloured flocculent deposit, and the fluid lost its red colour.

When the solution in alcohol was made extremely dilute so that the colour was the faintest yellow, and to this a drop of ammonia or potash was added, a deep red colour instantly appeared, whereas sodium carbonate precipitated the red pigment.

When shaken with amyl alcohol, the colour was distributed evenly between the aqueous solution and the alcohol.

Ferric alum gave a bluish-black colour and precipitate.

The pigment was precipitated by lead acetate, bromine, formaldehyde and hydrochloric acid, and potassium bichromate.

The red pigment was decomposed by fusion with potassium hydroxide at 200° C. The products of decomposition were isolated and identified as phloroglucinol, protocatechuic acid, and gallic acid.

Examination of the amorphous yellow deposit.

(4). This very fine yellowish-brown powder, formed during hydrolysis, was quite insoluble in water, alcohol, ether, or dilute acids. It was soluble, however, in water containing a few drops of ammonia, and formed a greenish-yellow fluid from which a heavy sulphur-yellow precipitate gradually separated. This yellow substance was carefully washed, dried, and examined:—

When shaken up with dilute hydrochloric acid, ferric alum produced in it, after 5 minutes, a navy-blue coloration and then a blue-black precipitate.

Concentrated sulphuric acid dissolved it to a bright yellow solution.

Concentrated nitric acid formed a very brilliant red liquid.

Glacial acetic acid did not dissolve the substance, but removed the yellow colour, and deposited a light grey precipitate.

Potassium hydroxide gave a bright yellow solution. The yellow powder heated to 200° C. darkened, but did not melt below 250°.

Some of these reactions recall the properties of Mr. H. G. Smith's aromadendron, obtained from eucalyptus exudations (Proc. Roy. Soc. N.S.W., xxx., 1896): the colours obtained above with the strong acids and alkali are the same, but all the other properties are different.

Examination of the insoluble portion of the indian-red deposit.

(5). This substance was an amorphous dark red powder, insoluble in water, dilute acids, alcohol, and the ordinary organic solvents. It was, however, rapidly acted on by water containing a few drops of ammonia, in which it partially dissolved, but the fluid soon became milky and a light yellowish-green precipitate settled. When this coloured substance was warmed with hydrochloric acid, it was

changed to a white insoluble compound. In concentrated sulphuric acid, it formed a yellow solution and, when this was poured into water, the white compound was again obtained. The latter was rapidly dissolved by alkalies to a deep yellow solution. When suspended in dilute acid and treated with ferric alum, it yielded a blue-black solution and precipitate. The yellowish-green powder was fused with alkali at 200° C. and its decomposition products separated. Phloroglucinol was identified, and also catechol, protocatechuic acid, and gallic acid.

Examination of the ethereal extracts.

(6). The ether from the precipitation of the red pigment (3) was combined with that obtained by shaking out the red fluid (2). The ether was removed by distillation and the residue was tested for flavones.

Although the ethereal solution was bright yellow in colour, the residue was red and granular. The greater portion of this residue dissolved in cold water to a red solution, and left a small amount of a yellowish-brown flaky substance. Both portions, when treated with ferric alum, gave a blue-black colour, and the flaky substance, after purifying, produced long white crystals with a melting-point of 220° C. This was subsequently proved by its reactions to be gallic acid. No flavones were present.

Examination of the residual red fluids.

(7). *The red filtrate from the lead acetate precipitation.*—This solution possessed the same brilliant red colour as the original. When boiled it deposited a brown precipitate. After removing the lead with sulphuric acid, the superfluid was colourless, and the latter when further heated with hydrochloric acid still remained colourless. The belief was thus confirmed, that the colourless solution did not contain the pseudo base of an anthocyanin, since under these conditions the original colour of the solution would have been restored.

(8). *The red solution after hydrolysis.*—When the insoluble deposits were removed from the acid fluid after hydrolysis the remaining liquid was still red in colour. This red solution differed from the previous one (7) in that prolonged boiling caused no precipitation or change in colour. The red pigment, however, was completely precipitated by formaldehyde and hydrochloric acid, and after some hours the colour of the fluid was but a pale brown. Complete precipitation and disappearance of the red colour was brought about also by potassium bichromate, and by bromine. Ferric alum produced a blue-black coloration and precipitate, which in certain concentrations exhibited a purple tinge.

The white deposit B.

This substance presented some remarkable characters, and was reserved for a later investigation. It appeared to be a very inert compound, and burned on platinum foil with a strong odour of burning rubber. It was a derivative of caoutchouc.

The phlobaphene deposit C.

The red extract, which was obtained in the beginning by steeping the red plant material in alcohol, when allowed to stand for some days, deposited insoluble phlobaphenes or anhydrides of the tannins. These were found to possess all the general properties of the catechol tannin anhydrides.

Tannin Estimations.

The British official method with chromated hide-powder was used in the determination of the amount of tannin in the powdered leaves.

Equal weights of normal green leaves and of red fasciated leaves of *Eucalyptus stricta*, air-dried and treated under exactly similar conditions, yielded the following results:—

Green leaves	18.8 % tannin.
Red „	24.5 „

Records of the Reddening of Plants after Injury.

Historical.—Parkin (1903), who studied the red pigments in a large number of different plants, has classified those occurring in leaves in the following four groups:—

(1). The transitory red of young foliage leaves.

(2). The autumnal tints.

(3). The permanent red of mature leaves.

(4). The accidental colouring due to exceptional conditions.

In the last group we find the red pigments that are developed by such conditions as excessive insolation in high mountain regions, lightning, raised temperatures, and again always as a result of injury.

Mer (1877) was one of the earliest observers of the formation, in plants, of pigment resulting from the injury caused by animal and vegetable parasites. He also made the important statement that oxygen was necessary for the production of red pigment.

An important study of the stimulation of cells was made by Hauptfleisch (1892), when he observed that the movement of protoplasm was greatly accelerated by injury to the adjoining cells, and in some plants, where no motion was observed under ordinary conditions, marked streaming of the protoplasm occurred.

In the red disease of vines, Zacharewicz (1905) observed that the leaves turned red when attacked by the red spider, *Tetranychus telarius.*

Parkin (1905) described a brilliant red pigment which could be produced on a species of *Jacobinia* by injuring the plant; and oxygen was found to be essential to its formation.

Mirande (1906) studied the ravages of a caterpillar on the leaves of *Galeopsis,* and the resulting formation of red pigment. The production of anthocyanin in this case was thought to be due to the formation of excess of tannin and glucose in the presence of oxidases.

It was shown by Gautier (1906) that wounds in the vine produced anthocyanin, and imitated the autumnal colouring in the leaves. He stated that the pigments were produced from coloured phenolic acids of the nature of tannins.

Mirande (1907) examined larval shelters built on sixty different plants. The conclusions that he drew were that the conditions necessary for the formation of red pigment are, firstly, the local interruption of the free current which brings about the accumulation of certain compounds in the tissues, such as phloroglucinol, tannin, glucose, etc.; and the presence of an oxidase enzyme. When one of these factors is wanting, no red pigment is formed.

From a great many observations of the flora of Japan, Miyoshi (1909) has recorded the formation of red pigment as a result of injury. He stated that

the colour first appears in the parts bitten by insects or in other ways injured, and from this position the pigment spreads till the whole of the leaf surfaces are coloured red.

In Pfeffer's "Physiology of Plants" (p. 495) it is stated that the red and blue anthocyanin pigments of cell-sap seem to be tannins or compounds allied to phenols. These old authors believed in the origin of anthocyanins from tannins. More recently this view has appeared again; for we have Politis (1911, 1923) who, from his microchemical investigations, concludes that anthocyanins are produced by special bodies, called cyanoplasts, which contain tannin; and Chodat (1912) who conducted certain experiments which suggested to him also their origin in the tannins.

The Rôle of the Oxidising Enzymes.—One notes that most of these investigators, whose work has been referred to above, have recognised the essential rôle of oxygen in the formation of leaf-pigment. The special study of this factor in plant-diseases has been carried out in the U.S. Bureau of Plant Industry. The mosaic disease of tobacco was explained by Woods (1902) on the basis of disturbance in the oxidase mechanism; there was invariably a greater quantity of oxidase in the pigmented than in the normal leaves.

In "leaf curl" of the potato, Sorauer found that the colour changes accompanying the disease were due to disturbance in the enzymatic equilibrium, and observed great intensity of the peroxidase reaction.

Bunzel (1913), studying the "curly top" of sugar-beets, found in the injured leaves an oxidase content two or three times as great as in normal plants.

It may be stated that, in general, most abnormal plants which have been examined, suffering from injury of any kind or whose growth has been stunted by adverse conditions, show this great increase in oxidase activity.

The Physiological Mechanism of Red Pigment Formation in Injured Plants.

Biophysical.—It is well recognised that plants in their own way, as well as animals, can respond to various injuries received, by increasing their vital activities. They react in a definite manner towards regaining their normal condition. We have instances of this in the formation of callus and cork after injury, and the irritation caused by parasites is often attended by abnormal growth. One gathers with interest, from recently recorded experimental work, that the plant, in rallying from the shock of injury, exhibits symptoms resembling those of injured animal tissues, such as increased respiration, rise of temperature, and local reddening. The stimulation of plant or animal tissues is followed by an accelerated respiration, and particularly after the stimulus of wounding.

Richards (1897) made the assumption that the extra work performed under the stimulus would necessitate a rise in temperature of the parts affected, and in his experimental work used a very efficient thermo-electric element and mirror galvanometer. By this means he measured the potential difference of temperature between injured and uninjured plants and obtained differences of three to four degrees centigrade. This rise of temperature after injury of the plant, and corresponding to the fever following the wounding of animal tissues, is the extra work due to the exertion of the vital forces of the organism in its attempt to recover; the vitality of the plant being, of course, on a much lower

level. The intensity of respiration is thus found to be the best measure of the increased activity of the injured plant.

Biochemical.—In normal respiration, or gaseous exchange in the plant tissue, the carbon dioxide evolved is of complex origin. Between the processes of absorption of oxygen and evolution of carbon dioxide, there is a close relationship under normal conditions, in which enzymes are known to take a large part. Much experimental work in this field has been carried out in the Cambridge School of Botany, and also by the French investigators. Their results have established the facts that the stimulus of respiration after injury produces rise of temperature of the adjacent tissues, an increased intake of oxygen, and an increased production of carbon dioxide; but that if the stimulus is great and the injury extensive, the evolution of carbon dioxide goes down, and the absorption of oxygen is no longer correlated with it. In non-tannin leaves the oxygen absorbed was very much lower than the carbon dioxide evolved, while in tannin-rich plants the oxygen intake was rapid, and remained at a high level, much greater than the carbon dioxide produced. The absorption of oxygen is in some way connected with the cell contents, and especially the tannins (Thoday).

The hypothesis of the role of oxygen in the formation of red pigments received the first evidence from the experiments of Molliard (1907). Certain plants growing in nutritive solutions of different composition showed that the parts below the water surface were unpigmented. All the conditions being the same, he concluded that lack of oxygen was the factor inhibiting the red pigment formation.

The work of Mirande, Laborde, Palladin, and Wheldale has confirmed that the formation of red pigment in leaves is always accompanied by increased oxidation, and occurs in a medium more oxidising than the normal medium; and that red leaves take in and fix more oxygen than green leaves.

Coombes (1910) showed experimentally that respiration of red leaves was much more active than of green leaves. The intake and fixation of oxygen is closely associated in some way with the action of oxidase enzymes. These are responsible for the discoloration of tissues, and the formation of red pigments after injury.

Onslow (1919) observed that the oxidase of potato is able to oxidise catechol and protocatechuic acid. This suggests that the red-brown pigments are due to the action of oxidase enzymes upon some such substances contained in the injured tissue. The catechol group present in the substrate is activated by the enzyme, and gives rise to the formation of red pigments.

Recapitulation.—The general effect of injury to a plant is to increase the intensity of its respiration. This comprehends rise of temperature above the normal, and great increase in the amount of oxygen fixed, especially in plants containing tannins. This increase is maintained after the injury, and the cell-contents are acted upon by oxidase enzymes which cause the formation of coloured compounds.

The balanced reactions are destroyed by mechanical injury, and then proceed always in the direction of hydrolysis, or the breaking up into simpler substances. The protoplasm of the injured cells loses its semi-permeability, and the pigments diffuse outwards, permeating the whole tissue and staining the protoplasm and the cell walls.

Conclusions drawn from the experimental work.

The plant extract, exhibiting a brilliant red colour, was examined in the special way to detect anthocyanins. Now much controversy has taken place, especially among French investigators, as to the real nature of the red pigments: the anthocyanin researches of certain authors were suspected by others of being concerned with tannins. There is no doubt that many of the conspicuous properties are held in common by these two groups, which are both sources of red pigment; and one must have had considerable experience to decide with certainty the group to which a pigment belongs. For this reason it was necessary to isolate the pigment, and identify its decomposition products.

The following characteristic reactions show decisively that the red pigment is formed from a catechol tannin, which has undergone decomposition as a result of injury to the plant.

The pigment was obtained in red flakes, and was non-crystalline, insoluble in dilute acids, but soluble in alkalies. It was precipitated by water from its alcoholic solution when made slightly acid, completely precipitated by bromine, formaldehyde, etc., and contained phloroglucinol, and gallic and protocatechuic acids. Anthocyanins were thus shown to be absent.

By simple extraction and shaking with ether, gallic acid was obtained. It was probably present as free acid in the tissues of the injured plant. It was likewise obtained after boiling with acid, in which case, however, the acid was liberated from combination as a constituent of some tannin glucoside.

In conclusion, the writer expresses his indebtedness to Professor Chapman for laboratory facilities.

Summary.

Leaves of *Eucalyptus stricta* were found to be injured by a microscopic mite, *Eriophyes eucalypti*, and, as a result, great fasciation had taken place, and a bright red colour had been produced.

The colouring matter of these red fasciated leaves was isolated and examined chemically. No trace of authocyanin could be identified, but instead, the pigment was proved to be a catechol tannin red. It was obtained in red non-crystalline flakes, and soluble in alcohol and alkalies. The reactions are given whereby it is distinguished from anthocyanins, many of the properties of which are held in common.

The red pigment is probably one of the first anhydrides, or soluble phlobaphenes, of a catechol tannin.

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MITE OF GENUS *ERIOPHYES* ASSOCIATED WITH MALFORMATION OF LEAVES OF *EUCALYPTUS STRICTA*.

By W. B. Gurney, F.E.S.

(One Text-figure).

[Read 27th August, 1924.]

This note contains the description of the mite which caused a red coloration in leaves and twigs of *Eucalyptus stricta;* the chemistry of the pigment produced has been investigated by Dr. J. M. Petrie (see pp. 386-394).

On the terminals of branches of *Eucalyptus stricta* at Mount Wilson on the Blue Mountains, distortion of the twigs and young leaves occurs frequently. This consists of thickening of the young terminal leaves and general reddening of the tissue, especially of the aborted leaves. The whole effect seems to be to stultify the growth and cause dense clusters or tufts of small, narrow, deep reddish leaves, giving a "Witch's Broom" appearance to the terminals. These malformations are at once noticeable at a distance on the saplings of this species of Eucalyptus (see Plate xliv.).

I gather from Mr. W. F. Blakely, of the Botanic Gardens, that other species of *Eucalyptus,* both on the Blue Mountains and near Sydney, have been noticed with somewhat similar reddish tufts of discoloured and distorted tips.

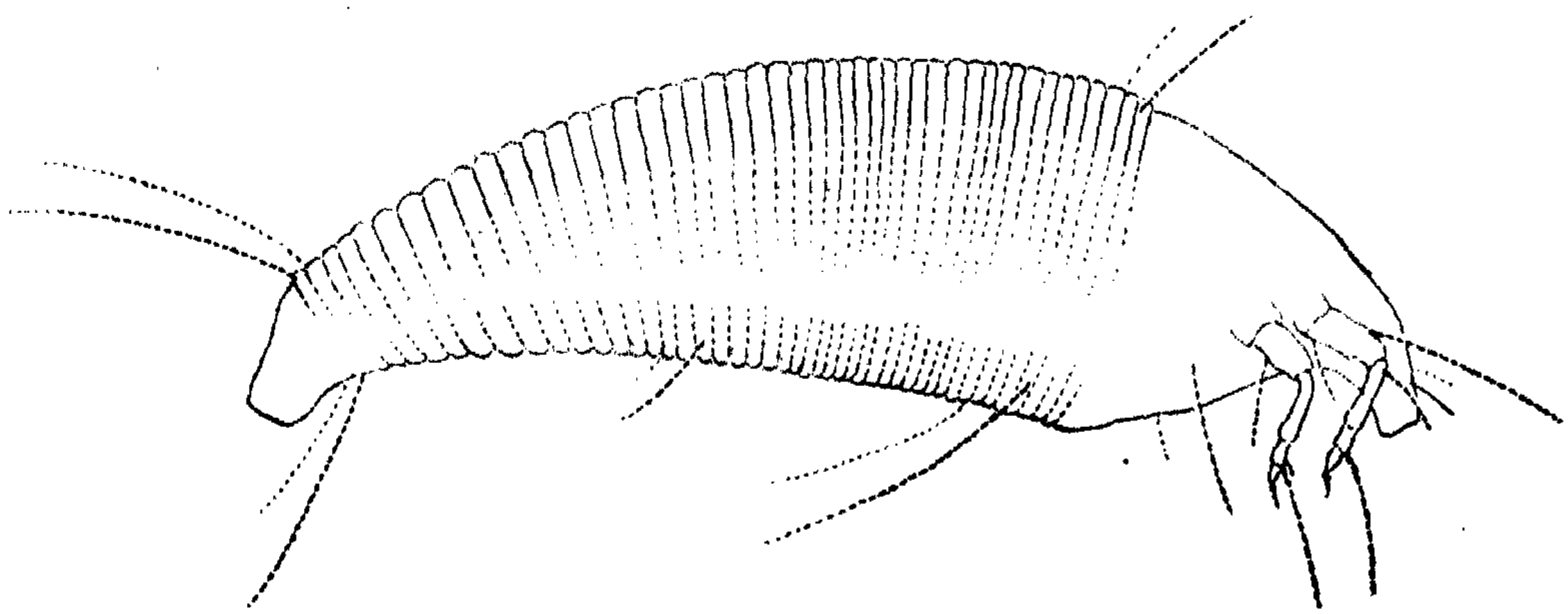
Examination of these reddish tufts collected for me from *E. stricta* in December, 1923, and in March, 1924, at Mount Wilson revealed the presence, in great numbers, of extremely small mites of the Family Eriophyidae, apparently of a new species of the genus *Eriophyes.* The immature stages were much smaller and exhibited fewer annular rings on the abdomen. The normal shape is elongate, cylindrical, and gradually tapering to both extremities.

The mouth parts include a pair of minute bristle-like mandibles and there is a pair of 3-jointed palpi. The species of this family of mites are minute, varying, according to Dr. Nalepa, from 80 to 280 μ and they characteristically cause deformities on the plants they infest. Their attacks often cause furry-looking spots called an erineum, and sometimes definite dimple, blister-like, or even elongate galls are found. This particular species frequents the bases and the surface of the leaves, especially the inner faces of the young leaves, affecting their growth and causing unnatural thickening and reddening of those leaves.

Eriophyes pyri, the Pear Leaf Blister mite, and *E. vitis,* causing "Erinose" of the grape vine, are well known pests of these hosts. I can find no reference to a species of this genus infesting Eucalyptus. Dr. Nalepa records one species

only of the Myrtaceae, viz., *Prunica granatum*, as being affected by an *Eriophyes* out of 144 species of this genus described by him.

I have to acknowledge gratefully the excellent figure of this minute form which Mr. E. H. Zeck has drawn to illustrate this description.



Eriophyes eucalypti, n.sp. (x 590)

Drawn by E. H. Zeck.

ERIOPHYES EUCALYPTI, n.sp.

The body elongate, cylindrical, tapering. Thoracic shield inconspicuous. Striae punctate, 42 to 52. Setae all present (except accessory setae, not noticed). Ventral seta 1 twice length of ventral seta 2. Legs medium size, basal segments relatively thick, segments 3 to 5 relatively thin. Claw longer than feathered hair which is 4-rayed. Length about 170 μ.

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REVISION OF AUSTRALIAN LEPIDOPTERA. LASIOCAMPIDAE.

By A. Jefferis Turner, M.D., F.E.S.

[Read 24th September, 1924.]

In the preparation of this revision, together with some corrections and additions to the families previously treated, I have been much assisted by the loan of specimens from the South Australian Museum, The National Museum, Melbourne, the Australian Museum, Sydney, and from Mr. G. Lyell, Mr. G. M. Goldfinch and other entomologists. Specially helpful has been the loan of some types from the Lucas Collection recently acquired by the South Australian Museum. Unfortunately some of the Lucasian types have not yet been discovered in this Collection.

Family LYMANTRIADAE.

Dr. Starr Jordan of California informs me that the generic name *Liparis* was used for a fish by Scopoli in 1777, antedating its use in the Lepidoptera. It seems, therefore, that we must use the name Lymantriadae for the family, Liparidae being inadmissible.

Porthesia xuthosterna, n.sp.

ξουθόστερνος tawny-breasted.

♂. 28-30 mm. Head and thorax white, more or less suffused with orange-ochreous; pectus orange-ochreous. Palpi white. Antennae whitish; pectinations grey. Abdomen white, with two, three, or four blackish median dorsal spots. Legs white; anterior pair, except tarsi, suffused in front with orange-ochreous. Forewings oval-triangular, costa rather strongly arched, apex rounded, termen bowed, moderately oblique; white; cilia white. Hindwings with termen rounded; white; cilia white.

Not unlike *P. euthysana* Turn., but there are no long spathulate ochreous scales on dorsal margin of forewings.

Queensland: National Park (2,000-4,000 ft.) in February and March.

New South Wales: Mt. Wilson (3,500 ft.) in November. Eight specimens.

Porthesia semifusca.

Orgyia semifusca Wlk., Char. Undescr. Lep. Het., 1869, 65; *Porthesia ? irrorata* Luc., Proc. Roy. Soc. Q'ld., 1892, 77; *Ocybola semifusca* Turn., Mem. Nat. Mus., Melb., iv., 1912, 5; *Porthesia melambaphes* Turn., Proc. Linn. Soc. N.S.W., 1920, 480.

According to Mr. J. A. Kershaw the ♀ has narrow rudimentary wings, but this character by itself scarcely justifies generic separation.

Victoria: Sale, Melbourne.

HABROPHYLLA EURYZONA.

Mr. J. D. Wilson has kindly sent me two females reared from larvae. They are completely apterous and the legs and antennae are much reduced. Although apterous females are not uncommon in this family, this is the first instance that I know of in the *Euproctis* group.

AXIOLOGA PURA.

There are two ♀ examples in the Lucas Collection labelled as this species in Mr. R. Illidge's handwriting. Neither of them corresponds with Lucas's description; his type, which cannot be found, was smaller, and had two dentate black lines. I think it may have been the ♂ of this species, though stated to be ♀. Until the ♂ has been rediscovered this must remain a conjecture.

DURA MARGINEPUNCTATA.

Previously known only from New Guinea and North Queensland, the range of this species has been recently discovered to extend much further south.

Queensland: Bunya Mountains (W. B. Barnard); New South Wales: Lismore (V. J. Robinson), Tuncurry (G. M. Goldfinch).

Genus OLENE.

A character of this genus which I have not previously noted is that, while the ♂ has two pairs of spurs on the posterior tibiae, in the ♀ the median spurs are absent.

OLENE OSTRACINA Turn.

The receipt, from Mr. W. B. Barnard, of an example of this species in much better condition than the type enables me to refer it to its right genus and to give a more accurate description.

♀. 45 mm. Head, palpi, antennae, thorax, abdomen, and legs whitish. A small ochreous posterior thoracic crest, and a larger ochreous crest on dorsum of second abdominal segment. Posterior tibiae with terminal spurs only. Forewings with costa strongly arched, apex rounded, termen nearly straight, moderately oblique; whitish; markings fuscous mixed with brown; a basal dot followed by a fine incomplete outwardly oblique line; a median, large, longitudinally oval, sub-basal spot; a finely dentate transverse line at one-third; a dentate and sinuate transverse line at two-thirds, preceded by a short transverse streak beneath costa; immediately followed by a large post-median blotch with a large truncate posterior process beneath costa, and another in middle, narrowing rapidly below middle, and not reaching dorsum; an interrupted crenulate submarginal line; cilia whitish. Hindwings and cilia whitish.

North Queensland: Cooktown in April.

Species wrongly referred.

Artaxa usta Luc., Proc. Roy. Soc. Q'ld., 1894, 106, belongs to the Drepanidae.

Family ANTHELIDAE.

Genus Anthela.

An examination of the types in the Lucas Collection has shown me that the species I have previously described as *A. magnifica* is really *A. asciscens* Luc. It is a larger species than the true *A. magnifica* Luc. which I have hitherto called *asciscens*. The latter has two white discal spots on the forewings, and the hindwings are fuscous without ochreous tinge.

Anthela callicesta, n.sp.

καλλίκεστός, beautifully figured.

♀. 58 mm. Head, palpi, antennae, and thorax dark-fuscous; pectus ochreous. Abdomen dark-fuscous; under surface ochreous. Legs dark-fuscous with a few whitish scales; coxae ochreous. Forewings triangular, costa straight to near apex, apex pointed, termen bowed, only slightly oblique; dark-fuscous with slight grey-whitish irroration; two very obscure, suffused, darker transverse lines; first from one-third costa to dorsum before middle, outwardly-curved; second from two-thirds costa to dorsum beyond middle, approximated to dorsal end of first line; a whitish discal dot at one-third before and touching first line; a larger, transversely-elongate, whitish discal spot before two-thirds, touching second line; a more slender, obscure, dark, subterminal line; a grey-whitish, rather narrow, terminal band, anteriorly sharply defined by a strongly crenated border; cilia grey-whitish. Hindwings with termen rounded; as forewings, but without discal spots. Underside similar but ochreous-tinged, basal half of disc mostly dark-fuscous; terminal half mostly greyish-ochreous; without discal spots, or with second spot on forewings just indicated. Very distinct by the scalloped grey border of wings.

New South Wales: Sydney in October; one specimen, which forms part of a general collection made entirely from within the boundaries of his own home by Dr. G. A. Waterhouse, who proposes to donate the type to the Australian Museum.

Species wrongly referred.

Darala rosea Luc., Proc. Linn. Soc. N.S.W., 1891, 291, belongs to the Limacodidae.

Darala consuta Luc., Proc. Roy. Soc. Q'ld., 1899, 139, is a synonym of *Cotana serranotata* Luc. (Eupterotidae).

Family SATURNIADAE.

Dr. R. J. Tillyard has kindly sent me particulars of the pupal tracheation of *Antheraea eucalypti*. The areole is absent (as I expected), but previous conjectures as to the missing veins of the forewings are disproved. In the pupa R_1 separates from Rs near the base, Rs is three-branched, and M is two-branched, instead of four and three-branched respectively as in normal Heterocera.

Translating this into the usual notation, the definition should be amended thus—veins 5 and 6 coincident, 10 absent (rarely present and separating just before apex).

Genus Antheraea.

Vein 11 of forewings, which usually separates towards apex, may be absent. It is so sometimes in *A. astrophela*, so also in the species here described.

ANTHERAEA SACCOPOEA, n.sp.

σακκοποιος, making bags or sacks.

♂. 84-94 mm. Head purple-reddish. Palpi very short; purple-reddish; upper surface and apex ochreous. Antennae ochreous. Thorax and abdomen purple-reddish. Legs purple-reddish tinged with ochreous. Forewings triangular, costa straight to beyond middle, thence strongly arched, apex rounded-rectangular, termen straight, slightly oblique; purple-reddish; suffused with grey on costa; ocellus post-median, small, circular, faintly outlined with purplish, a narrow white curved line on inner aspect followed by a crimson meniscus, remainder ochreous with a narrow, transverse, slit-like hyaline centre; a whitish subterminal line edged on both sides with purplish, nearly straight, from costa shortly before apex to two-thirds dorsum; an obscure purple-crimson apical patch; cilia concolorous, apices whitish. Hindwings with termen very slightly rounded, tornus prominent; colour as forewings; ocellus as forewings, but outlined with fuscous and without hyaline centre; subterminal line similar but curved and wavy; a darker suffused antemedian transverse line. Underside similar but duller; ocelli encircled with whitish.

♀. 104 mm. Similar but wings grey; hindwings with termen more rounded and tornus less prominent.

North Queensland: Cooktown; two specimens received from Mr. W. B. Barnard. The larvae pupate in large irregularly shaped bags of loose brown silk, in which each spins a separate loose cocoon. These bags are spun among the twigs and leaves of a shrub locally known as "wild guava" or "wild pear" in the bush within thirty miles of Cooktown. Twenty or thirty may emerge from a single bag; they emerged in Toowoomba in March, but unfortunately nearly all failed to expand their wings, and were badly crippled. This may have been due to the drier atmosphere of that place.

Family BOMBYCIDAE.

On reconsideration, I have come to the conclusion that the Eupterotidae cannot be separated from this family. It may be noted that my definitions of these two families previously given are practically identical, and it is unnecessary to repeat them. Even after this amalgamation the family is only of moderate size. The few Australian genera may be separated by the following key:—

1.	Both wings with 5 from upper angle of cell	2.
	Both wings with 5 from beneath upper angle	4.
2.	Forewings with 9, 10 closely approximated to 11 in posterior third of wing, and usually connected with it by a crossbar	*Cotana*
	Forewings not so	3.
3.	Both wings with 3 and 4 stalked	*Panacela*
	Both wings with 3 and 4 separate	*Mallodeta*
4.	Both wings with vein 1 absent	*Eupterote*
	Both wings with vein 1 present	*Gastridiota*

GASTRIDIOTA ADOXIMA.

♂. 26-31 mm. Head, thorax, and antennae dark chocolate-brown; face sometimes paler. Abdomen dark chocolate-brown; tuft with spreading hairs, which have fuscous apices. Forewings triangular, costa straight to near apex, apex pointed, termen nearly straight, slightly oblique; dark chocolate-brown; a triangular costal area with whitish or ochreous-whitish irroration, from one-

fourth gradually increasing in breadth to middle, where it ends abruptly; in this is a small darker discal spot with pale centre; a short transverse mark of similar colour on costa before three-fourths; an ochreous mark on dorsum beyond middle, followed by a dark line, and this by some ochreous irroration; cilia concolorous. Hindwings with termen rounded, tornus prominent; dark chocolate-brown; a slight ochreous irroration on termen above middle; a paler irroration on dorsum from one-fourth to three-fourths, followed by a dark line, and this by a pale mark; cilia ochreous, on dorsum chocolate-brown mixed with ochreous-whitish on dorsal markings.

I have received two males from Mr. V. J. Robinson, who has bred the species from larvae feeding on *Ficus* at Rous, near Lismore, N.S.W.

Family NOTODONTIDAE.

Subfamily CNETHOCAMPINAE.

Genus Mesodrepta nov.

μεσο-δρεπτος, picked out from the middle.

Palpi obsolete. Posterior tibiae without middle spurs. Forewings with 5 from about middle of cell, 6 from upper angle, areole present but rather small, 7, 8, 9 stalked, 10 connate with them. Hindwings with 3 and 4 separate, 5 from middle of cell, 6 and 7 stalked, 12 approximated to cell to beyond middle, not connected.

An interesting discovery intermediate between *Cynosarga*, with which it agrees in neuration, and *Epicoma*, with which it agrees in the absence of palpi and middle spurs. It clearly indicates the ancestry of the latter genus.

Mesodrepta harpotoma, n.sp.

ἁρπότομος, divided by a sickle.

♂♀. 38-45 mm. Head grey-whitish; face ochreous. Antennae whitish; pectinations in ♂ 10, in ♀ 5, ochreous-tinged. Thorax white, anteriorly greyish-tinged. Abdomen ochreous; in ♀ annulated with dark-fuscous; tuft and underside white. Legs white; anterior pair ochreous mixed with blackish on dorsum. Forewings triangular, costa straight, in ♀ slightly arched, apex round-pointed, termen bowed, slightly oblique; a narrow, outwardly curved, sickle-shaped fascia from mid-dorsum to costa shortly before apex, broadest on dorsum, thence gradually narrowing, blackish, crossed by short ochreous streaks on veins; cilia white. Hindwings with termen rounded, white, cilia white. Underside wholly white. The sexes are similar.

Queensland: Toowoomba in December. I have received two examples of this very distinct species from Mr. W. B. Barnard, who has generously given me the type.

Subfamily NOTODONTINAE.

Omichlis hadromenes.

In Mr. W. B. Barnard's Collection is a striking ♂ aberration in which a fuscous median streak extends from base to termen. It is from Kuranda (F. P. Dodd).

Family LASIOCAMPIDAE.

Tongue absent. Maxillary palpi obsolete. Labial palpi moderate or long, porrect. Eyes often small, usually hairy. Thorax and abdomen stout, densely hairy. Legs densely hairy; posterior tibiae without middle spurs, all terminal spurs very short. Forewings with cell small, areole never present; anal vein

not furcate at base; 1 absent, or rarely weakly developed towards termen; 2 from near base, 3 usually from about middle of cell, 4 and 5 approximated from angle, 6 from upper angle, 9 and 10 always stalked. Hindwings with two anal veins, 1 absent, 7 from well before angle of cell, usually from near base (except in *Perna* and *Neurochyta*), 11 running into 12, or replaced by an anastomosis of 12, with 7 near its base, or more rarely with cell; from the subcostal cell so formed arise usually one or more pseudoneuria, which are often branched in an irregular and sometimes arborescent fashion. Frenulum and retinaculum absent in both sexes; hindwings with a strong basal costal expansion.

The Lasiocampidae are found in all continental areas, and are no doubt an ancient group which specialised early (1) by the loss of the interradial cross-vein or anastomosis between 8 and 9 and consequently of the areole, (2) by the loss of frenulum and strong costal expansion of hindwing leading in these heavy-bodied moths to connections of the subcostal and radial veins in that region, with the development of pseudoneuria. They are an isolated group and whether there are any exotic families which should be grouped with them in the same superfamily is doubtful.

The subcostal cell of the hindwing appears to have been formed originally by vein 11 (the first radial) running into 12 (the subcostal). This is a structure that occurs in many families, but the Lasiocampidae were peculiar in having 11 arising from near the upper angle of the cell, sometimes even stalked with 7. Two lines of development followed, firstly, the loss of 11 and its replacement by an anastomosis and, secondly, a displacement of the origin of 7 along the costal edge of the cell, until it arose from near the base. Accordingly the genera appear to fall into three natural groups: (1) those in which 11 is retained, such as *Perna*, in which the subcostal cell is unusually large, and the European *Odonestis*, in which it is more moderate; to this section I refer also the African genus *Anadiasa*; (2) those in which 7 still arises from near the angle of cell, but the subcostal cell is much smaller and 12 anastomoses with the cell before the origin to 7; of these *Neurochyta*, the European *Clisiocampa*, and the African *Bombycomorpha* are examples; (3) those in which 12 anastomoses with 7 close to its origin from near the base of the cell; these comprise the bulk of the family, and all the Australian genera except the two already mentioned.

This revision contains 54 species referred to 12 genera. In number of species this exceeds Europe (31 species) and North America (24 species), and equals India (54 species). The family is most numerous in Africa, and the South African list comprises 88 species. The species of Lasiocampidae, at least the females, are mostly sluggish in their habits and do not appear to range very widely. So far as known, all our genera are confined to the Australian region; but until those of other regions have been critically examined, this cannot be affirmed with certainty. In any case the proportion of endemic genera is probably large.

Key to genera.

1. Hindwings with 11 absent, 12 anastomosing with cell, or with 7 near its base .. .. 2.
   Hindwings with 11 present .. .. *Perna*
2. Hindwings with 12 anastomosing with 7 near its base .. .. .. 3.
   Hindwings with 12 anastomosing with cell before origin of 7 .. *Neurochyta*
3. Palpi short or moderate, not exceeding frontal tuft .. .. 4.
   Palpi long, much exceeding frontal tuft .. .. 10.

4.	Hindwings with cell exceeding ½	5.
	Hindwings with cell ½ or less	6.
5.	Forewings with 6, 7, 8 stalked	*Pinara*
	Forewings with 8 separate	*Crexa*
6.	Forewings with 7, 8 stalked, 6 separate	*Eremaea*
	Forewings with 6, 7 stalked or rarely connate	7.
7.	Hindwings with subcostal cell minute or obsolete	*Eremonoma*
	Hindwings with subcostal cell well developed	8.
8.	Hindwings with 4 and 5 stalked	9.
	Hindwings with 4 and 5 separate	*Porela*
9.	Eyes smooth	*Cyclophragma*
	Eyes hairy	*Symphyta*
10.	Hindwings with 4 and 5 stalked	11.
	Hindwings with 4 and 5 separate	*Opsirhina*
11.	Eyes smooth	*Entometa*
	Eyes hairy	*Digglesia*

1. Genus Pinara.

Wlk., Cat. Brit. Mus., iii., 761. Type, *P. cana* Wlk.

Eyes small, hairy. Palpi short, not exceeding frontal tuft. Forewings elongate; 6, 7, 8 stalked, 8 separating before or opposite 6. Hindwings in ♂ more or less produced at tornus; cell exceeding ½, 11 absent, 12 anastomosing with 7 near its base, subcostal cell moderate, giving origin to a single pseudoneurium near its base.

This genus, like the two following, has very dissimilar sexes. The males are considerably smaller than the females, with narrower forewings, hindwings more prominent at tornus, coloration much darker and more pronounced. The species require careful discrimination, the females especially being closely similar.

Key to males.

1.	Forewings very narrow, termen strongly sinuate	*sesioides*
	Forewings broader, termen not or only slightly sinuate	2.
2.	Forewings with large pale tornal blotch extending along dorsum to base	*cana*
	Forewings without tornal blotch	3.
3.	Forewings fuscous-grey	*obliqua*
	Forewings reddish-brown	*metaphaea*

Key to females.

1.	Hindwings whitish	*obliqua*
	Hindwings grey	*cana*
	Hindwings fuscous	2.
2.	Hindwings wholly fuscous	*sesioides*
	Hindwings with whitish terminal band	*metaphaea*

1. Pinara sesioides.

Eumeta sesioides, Wlk., Cat. Brit. Mus., xxxv., 1924.

♂. 38-40 mm. Head and thorax grey. Palpi grey. Antennae grey; pectinations dark-fuscous. Abdomen grey, tuft tipped with dark-crimson. Legs grey. Forewings narrowly triangular, costa straight to near apex, apex rounded, termen very long, strongly oblique, strongly sinuate; grey, towards base and costa suffused with dark-crimson, extreme base ochreous-tinged; a whitish transverse line near base; a whitish transverse median discal mark; a whitish line from four-fifths costa to four-fifths dorsum, slightly outwardly curved or sinuate;

posterior to this a wavy series of subterminal dots, their inner halves ochreous, outer halves blackish; cilia grey. Hindwings small, costa short, tornus rounded, projecting; dorsal area grey; a dark-fuscous costal blotch; a triangular ochreous-brown terminal blotch; cilia dark-grey, apices whitish.

Described from two examples, including the type, in the British Museum. The locality labels are "Moreton Bay." There is a pair in the Queensland Museum obtained from Brisbane pupae by Mr. H. Hacker. The ♂ is 35 mm., the ♀ 50 mm. Head, thorax, and forewings pale-grey; the latter without markings except the usual dichroic subterminal spots. Abdomen and hindwings pale-fuscous.

This species is near *P. metaphaea,* but the forewings of ♂ are narrower, termen strongly sinuate, and ochreous blotch on hindwing triangular; while in ♀ the hindwings have no pale margin.

2. Pinara cana.

♀. Wlk., Cat. Brit. Mus., iii., 761.—♂. *Entometa divisa* Wlk., ibid., iv., 973.—*Opsirhina punctilinea* Wlk., Char. Undesc. Lep., p. 67.

♂. 36-38 mm. Head, palpi, thorax, and abdomen dark-grey. Antennae fuscous, stalk grey. Legs grey; tarsi fuscous annulated with whitish. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen slightly bowed, very oblique; fuscous; a large tornal grey blotch, curved upwards to reach discal spot, and prolonged to base between dorsum and vein 1, sharply defined from fuscous area, from which it is sometimes separated by a fine whitish line towards base; sometimes a pale transverse line traverses fuscous area near base, but this is usually absent; a transversely constricted, whitish, discal spot on end of cell; a fine whitish line from three-fourths costa very seldom traceable to dorsum before tornus, followed in dorsal half by a series of spots, anteriorly orange, posteriorly blackish; cilia fuscous. Hindwings produced at tornus, termen rounded, grey or fuscous; sometimes a large orange blotch in centre extending from termen nearly to base, but this may be wholly absent. An aberrant ♂ from Mt. Lofty lacks the pale dorsal blotch on forewings.

♀. 43-68 mm. Head, thorax, and abdomen grey. Palpi fuscous, grey above and beneath. Antennae blackish. Legs grey; tarsi fuscous with whitish annulations. Forewings oval-triangular, costa gently arched, apex round-pointed, termen bowed, oblique; grey; sometimes paler ante-median and post-median transverse lines; the latter followed by a doubly sinuous line of dots, anteriorly orange, posteriorly blackish; cilia grey. Hindwings with termen rounded; grey; sometimes a suffused fuscous subtornal spot; cilia grey.

North Queensland: Prince of Wales Island, Herberton; Queensland: Rockhampton, Duaringa, Brisbane, Stanthorpe; New South Wales: Glen Innes; Victoria: Melbourne, Gisborne, Bamawm; Tasmania: Launceston; South Australia: Adelaide, Mt. Lofty; Western Australia: Perth.

3. Pinara obliqua.

♂. *Entometa obliqua* Wlk., Cat. Brit. Mus., iv., 973; *Rhinogyne calligama* Feld., Reise Nov., Pl. 84, f. 9, 10.

♂. 43-44 mm. Head, antennae, thorax, abdomen, and legs fuscous. Palpi fuscous, beneath grey-whitish. Forewings narrowly triangular, costa nearly straight, apex rounded, termen sinuate, strongly oblique; fuscous with general sparse whitish irroration, rather more pronounced in median area; a darker basal patch; sometimes a curved transverse fuscous line at one-fourth; some-

times a minute whitish transverse discal mark at end of cell; a doubly sinuate, subterminal line of spots, dark-fuscous edged anteriorly with orange; cilia fuscous. Hindwings with termen rounded, flattened or sinuate in middle; dark-fuscous; a large orange terminal blotch extending from apex to tornus; cilia orange, on costa and dorsum fuscous.

♀. 58-68 mm. Head and thorax grey-whitish. Palpi grey-whitish, external surface narrowly dark-fuscous. Antennae dark-fuscous. Abdomen fuscous (rarely grey); tuft whitish. Legs grey-whitish; tarsi dark-fuscous with whitish annulations. Forewings elongate, but broader than in ♂, termen slightly bowed; grey-whitish; an outwardly curved grey line from one-third costa to three-fourths dorsum, rarely obsolete; a second similar line precedes subterminal series of spots, which are as in ♂; cilia grey-whitish. Hindwings with termen rounded; whitish; a suffused grey spot above tornus.

A dwarf ♂ from Launceston expands only 34 mm.

New South Wales: Newcastle, Mt. Kosciusko; Victoria: Melbourne, Lilydale, Gisborne; Tasmania: Launceston; South Australia: Adelaide, Mt. Lofty.

4. Pinara metaphaea.

♀. *Opsirrhina metaphaea* Wlk., Cat. Brit. Mus., xxxii., 556.—♂. *Entometa adusta* Wlk., Char. Undesc. Lep., p. 16.—♂. *Pinara rufescens* Butl., Trans. Ent. Soc., 1886, 387.

♂. 34-42 mm. Head, palpi, thorax, and abdomen reddish-brown. Antennae fuscous, stalk paler. Legs reddish-brown; tarsi fuscous with whitish annulations. Forewings narrowly triangular, costa straight to near apex, apex round-pointed, termen slightly bowed, very oblique; reddish-brown; a dark-red basal suffusion more or less prolonged beneath costa; a curved, whitish, sub-basal transverse line; a whitish, constricted, discal spot on end of cell; a fine, sinuate, whitish line from four-fifths costa to dorsum before tornus, followed by a doubly sinuate line of spots, anteriorly orange, posteriorly blackish; cilia reddish-brown. Hindwings strongly produced at tornus, termen rounded; dark-reddish-fuscous; a rather narrow, orange, terminal band, partly interrupted on veins; scarcely reaching apex and tornus; cilia pale-ochreous, on tornus and dorsum brownish.

♀. 56-64 mm. Head and thorax grey. Palpi grey; fuscous towards apex. Antennae blackish. Abdomen fuscous; the two terminal segments and tuft pale-grey. Legs grey; tarsi fuscous with whitish annulations. Forewings elongate-oval; costa gently arched, apex round-pointed, termen bowed oblique; grey, paler towards termen; a darker grey, outwardly-curved line from one-third costa to one-third dorsum; a similar sinuate line from two-thirds costa to two-thirds dorsum, followed by a doubly sinuate line of spots, anteriorly orange, posteriorly blackish; cilia pale grey. Hindwings with termen rounded; fuscous; a grey-whitish, terminal band; cilia grey-whitish, on dorsum fuscous.

P. rufescens Butl. is an aberrant ♂ with the hindwings uniform pale brownish-grey without orange, terminal band.

Queensland: Rockhampton, Nambour, Brisbane; Victoria: Warburton; New South Wales.

2. Genus Crexa.

Wlk., Cat. Brit. Mus., xxxv., 1927. Type, *C. punctigera* Wlk.

Eyes rather small, hairy. Palpi short or very short. Forewings elongate; 6 and 7 stalked, 8 separate. Hindwings in ♂ produced at tornus; cell exceeding

½, 11 absent, 12 anastomosing with 7 near its base, subcostal cell moderate, giving origin to a single pseudoneurium near its base.

Closely corresponding in structure to *Pinara*, but 8 of forewings not stalked; though this character varies in some genera, in this instance it appears reliable, and separates two natural genera. Like *Pinara* it has usually dissimilar sexes, the males much smaller and with the forewings partly hyaline; the females, however, differ more from each other than the males of the several species. But in *acedesta* and *fola* the sexes are similar.

Key to males.

1.	Forewings mostly hyaline	2.
	Forewings not mostly hyaline	4.
2.	Forewings with pretornal blotch and dentate postmedian line whitish	*rhoda*
	Forewings without these markings	3.
3.	Forewings with double fuscous discal spots	*punctigera*
	Forewings with single discal spot	*subnotata*
4.	Hindwings fulvous-brown	*macroptila*
	Hindwings grey	5.
5.	Forewings with broad median brownish band	*fola*
	Forewings without median band	*acedesta*

Key to females.

1.	Hindwings without whitish lines	2.
	Hindwings with whitish lines	3.
2.	Forewings with discal spot large, circular, triangularly edged with blackish both anteriorly and posteriorly	*punctigera*
	Forewings with discal spot small or obsolete	*fola*
3.	Forewings with defined white postmedian fascia	*dianipha*
	Forewings without defined white fascia	4.
4.	Forewings with large postmedian whitish suffusion	*rhoda*
	Forewings without large whitish suffusion	5.
5.	Forewings with discal spot ochreous-brown with whitish centre, edged with blackish anteriorly and posteriorly	*acedesta*
	Forewings with discal spot not so	*subnotata*

5. CREXA PUNCTIGERA.

♂. *Entometa punctigera* Wlk., Cat. Brit. Mus., iv., 974.—♀. *Mecytha trimacula* Wlk., ibid., v., 1122.—♂. *Crexa anthraxoides* Wlk., ibid., xxxv., p. 1926.—♀. *Dichromosoma majus* Feld., Reise Nov., Pl. 83, f. 26.—♂. *Bombyx picta* Luc., Trans. Nat. Hist. Soc. Q'ld., 1894, 105.

♂. 32-34 mm. Head whitish. Palpi, antennae, and thorax dark-fuscous. Abdomen fuscous-brown. Legs fuscous; hairs on middle tibiae whitish; tarsi sometimes with fine whitish annulations. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen nearly straight, oblique; pale-fuscous but very thinly scaled, nearly hyaline; markings dark-fuscous; a broad dorsal suffusion from base to termen; two discal dots, one before, and one beyond end of cell; an apical suffusion; a subterminal series of spots; cilia fuscous. Hindwings produced at tornus, termen rounded; fuscous, rather thinly scaled; cilia fuscous.

♀. 40-52 mm. Head white. Palpi dark-fuscous with a white spot on middle of under surface of second joint. Antennae dark-fuscous. Thorax white with three fuscous spots, one anterior, two median. Abdomen fuscous; tuft white. Legs fuscous; hairs on middle tibiae white; tibiae and tarsi annulated with white.

Forewings triangular, costa straight to near apex, apex rounded, termen bowed, oblique; fuscous; some transverse white strigulae towards base, and slight whitish irroration towards termen; a fine white dentate transverse line at one-fifth; two triangular blackish discal marks enclosing between them a circular fuscous area with a central white dot; a blackish mark above mid-dorsum; a white spot on ¾ costa giving rise to a finely dentate, sinuate, white line to two-thirds dorsum; a submarginal series of dark-fuscous spots, margined with white; cilia fuscous. Hindwings with termen rounded; fuscous; cilia fuscous.

North Queensland: Cape York, Cairns; Queensland: Brisbane; New South Wales: Sydney; Victoria: Melbourne, Gisborne; Tasmania: Launceston, Ulverstone, Hobart, Geeveston; South Australia: Mt. Lofty.

6. Crexa subnotata.

♀. *Tolype subnotata* Wlk., Char. Undescr. Lep. Het., 1869, 67.—♀. *Sitina albicans* Swin., Cat. Oxf. Mus., i., 1892, 268, Pl. vi., f. 10.—♀. *Bombyx pinnalis* Luc., Trans. Nat. Hist. Soc. Q'ld., 1894, 103.—♂. *Crexa hyaloessa* Turn., Trans. Roy. Soc. S. Aust., 1902, 184.

♂. 25-30 mm. Head whitish. Palpi, antennae, thorax, abdomen, and legs fuscous. Forewings elongate-triangular, costa sinuate, apex rounded, termen slightly bowed, strongly oblique; mostly hyaline and very sparingly scaled; dorsal area beneath cell and vein 2 fuscous, with an oval blackish spot above mid-dorsum, and crossed before and beyond this by slender whitish lines, some whitish irroration between lines; a suffused fuscous streak along costa from middle to and around apex, interrupted by a white dot at three-fourths; three or four subapical blackish dots edged posteriorly by a slender whitish line; cilia fuscous. Hindwings strongly produced at tornus; hyaline with large dorsal and smaller costal fuscous areas.

♀. 35-55 mm. Head white. Palpi and antennae fuscous. Thorax white; a large postmedian fuscous blotch, crossed near its anterior extremity by a fine transverse white line. Abdomen fuscous, sometimes partly mixed with white; three apical segments white, but apex of tuft fuscous. Legs whitish; tibiae and tarsi fuscous with whitish annulations. Forewings elongate-triangular, costa very slightly arched, apex rounded, termen bowed, oblique; white suffused, except near base, with pale-grey; several grey spots near base; a wavy transverse white line, edged with grey, from one-third costa to one-third dorsum; a minute, white, median, discal mark; a white line from two-thirds costa, at first transverse then bent inwards and dentate to two-thirds dorsum; a fuscous blotch on dorsum between lines, rounded above; a submarginal series of dark-grey spots, edged posteriorly by a white line; terminal edge and cilia dark-grey. Hindwings with termen rounded; whitish; a transverse median grey line, broader on costa; a subterminal grey fascia interrupted on veins; cilia whitish.

Queensland: Clermont, Brisbane, Charleville; Victoria: Melbourne, Gisborne, Leopold; South Australia: Quorn; Western Australia: Perth, Geraldton.

7. Crexa rhoda.

Sitina rhoda, Swin., Ann. Mag. Nat. Hist. (7), ix., 1902, 82.

♂. 26-27 mm. Head whitish-ochreous. Palpi 1¼; whitish. Antennae and thorax fuscous. Abdomen brown, towards apex fuscous, tuft whitish. Legs whitish-ochreous; tibiae with fuscous sub-basal and subapical spots on external surface. Forewings elongate-triangular, costa sinuate, apex rounded, termen

very long, very slightly bowed, oblique; the greater part of disc very thinly scaled and translucent; a fuscous basal patch prolonged along costa to apex, and from thence narrowly along termen, where it becomes ochreous-brown; a slender wavy transverse line from one-third costa to mid-dorsum; an ochreous-whitish discal spot beneath midcosta; a similar spot on costa at three-fourths giving rise to a fine dentate line to tornus; a pretornal whitish blotch not reaching dorsum; a fine whitish dentate subterminal line; veins in posterior part of disc ochreous-brown; cilia ochreous-brown. Hindwings elongate, dorsum very long, tornus prominent, termen slightly rounded; pale-ochreous with a large fuscous-brown terminal blotch; cilia brown.

♀. 36-40 mm. Head and thorax ochreous-whitish. Palpi 2½; terminal joint longer than second, with appressed hairs; whitish. Antennae whitish, pectinations brownish. Abdomen pale ochreous-brown, towards apex ochreous-whitish. Legs whitish; tibiae and tarsi spotted with fuscous. Forewings triangular, costa straight to near apex, apex rounded, termen bowed, oblique; pale-ochreous-brown; near base suffused or spotted with whitish; a slender whitish dentate transverse line from one-third costa to one-third dorsum; a slight whitish irroration posterior to this; a whitish discal spot beneath midcosta; a whitish mark on four-fifths costa running into a large post-median whitish suffusion extending to dorsum and nearly to termen; a dentate whitish subterminal line; cilia pale ochreous-brown. Hindwings with termen rounded; pale-ochreous-brown; a broad median whitish transverse line; an interrupted whitish subterminal line; cilia pale ochreous-brown.

There is a series including the type in the British Museum. The ♀ palpi are unusually long for this genus, those of the ♂ are normal.

N.W. A.: Sherlock River.

8. Crexa macroptila.

♂. Turn., Ann. Q'ld. Mus., x., 1911, 92.

North Queensland: Chillagoe.

9. Crexa dianipha.

♀. Turn., Ann. Q'ld. Mus., x., 1911, 92.

North Queensland: Cape York.

10. Crexa acedesta.

Turn., Ann. Q'ld. Mus., x., 1911, 94.—*Sitina cinyra* Swin., Ann. Mag. Nat. Hist. (8), xix., 1917, 333.

Victoria: Melbourne, Birchip; South Australia: Adelaide; Western Australia: Perth.

11. Crexa fola.

Clathe fola, Swin., Ann. Mag. Nat. Hist. (7), ix., 1902, 82.

♂. 21-22 mm. ♀. 26-27 mm. Head, palpi, and thorax pale-grey. Antennae pale-grey; pectinations in ♂ 10, in ♀ 2½. Abdomen grey. Legs grey. Forewings triangular, costa straight nearly to apex, apex rounded, termen slightly bowed, scarcely oblique; pale-grey; a broad median brownish band occupies nearly half of wing, and is edged by slender whitish lines; in ♀ this may be obsolete, its edges being represented by slender grey lines; sometimes a faintly darker discal spot; a subterminal series of fuscous dots, sometimes indistinct; cilia grey. Hindwings with termen rounded; grey; cilia grey.

There is a series including the type in the British Museum. In the fore-

wings vein 8 usually arises separately from the cell, but in the ♂ may be connate or short-stalked with 9, 10.

N.W.A.: Roeburne, Sherlock River.

3. Genus Eremaea.

Turn., Trans. Roy. Soc. S. Aust., 1915, 803. (ἐρημαῖος living in the desert) Type, *E. zonospila* Low.

Eyes moderate, smooth. Palpi short. Thorax and abdomen very densely hairy. Forewings with 6 separate, 7 and 8 stalked. Hindwings with discocellular not developed leaving cell open, occasionally a slight indication of dorsal end of discocellular is present, and 4 and 5 are seen to be stalked, 11 absent, 12 anastomosing with 7 near base, subcostal cell small, pseudoneuria scarcely or not developed.

An isolated genus.

12. Eremaea zonospila.

Bombyx zonospila Low., Trans. Roy. Soc. S. Aust., 1893, 150.

♂. 34-40 mm. Head and thorax whitish. Palpi fuscous. Antennae ochreous-brown, stalk grey. Abdomen ochreous or ochreous-fuscous; beneath whitish. Legs whitish. Forewings triangular, costa straight, apex rounded, termen strongly bowed, slightly oblique; whitish or grey-whitish; two finely dentate, dark-fuscous, oblique lines, first from one-fourth dorsum to beneath one-third costa, edged posteriorly with ochreous, second from mid-dorsum to beneath two-thirds costa, edged anteriorly with ochreous; cilia whitish. Hindwings with termen rounded; densely hairy towards base; fuscous; cilia whitish.

♀. 42-62 mm. Head, palpi, antennae, thorax, abdomen, and legs whitish-ochreous or fuscous. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; whitish-ochreous or fuscous with some whitish irroration; sometimes indistinct oblique antemedian and postmedian darker lines; cilia concolorous. Hindwings with termen rounded; colour and cilia as forewings.

The sexes are so dissimilar that I should not have suspected them to be the same species, if Mrs. Williams of Cairns Station near Charleville had not forwarded me four males and six females. The peculiar neuration is the same in both, so that there is little room for doubt.

Queensland: Charleville; South Australia: Ooldea, Eucla, Musgrave Ranges; Western Australia: Kalgoorlie.

This is an inhabitant of the arid interior.

Genus Eremonoma nov.

ἐρημό-νόμος, an inhabitant of the desert.

Eyes moderate or rather large, smooth or hairy. Palpi short, not reaching beyond frontal tuft. Forewings with 2 from one-third, 6 and 7 stalked, 8 connate or short-stalked with them; 11 from two-thirds. Hindwings with 4 and 5 separate or short-stalked, 7 from about middle of cell, 11 absent, 12 anastomosing with cell from near base to origin of 7, and with basal part of 7, subcostal cell minute or absent, a large and usually branching pseudoneurium from base; cell one-fourth or one-third.

Type, *E. apasta*. This genus affects dry country. It is specialised by the loss or extreme reduction of the subcostal cell by coalescence. In the first two species the eyes are smooth, in the last two hairy. Possibly when more material is available it may be advisable to divide the genus.

Key to species.

1.	Forewings reddish	*apasta*
	Forewings whitish	*zoristis*
	Forewings grey	2.
2.	Forewings with fuscous transverse lines	*nephelodes*
	Forewings without markings	*holopolia*

13. Eremonoma apasta, n.sp.

ἄπαστος, unsprinkled.

♂. 25 mm. Head, palpi, thorax, abdomen, and legs dull-reddish. Antennae reddish; pectinations whitish-ochreous. Forewings triangular, costa straight to near apex, apex round-pointed, termen nearly straight, slightly oblique; dull-reddish; cilia dull-reddish. Hindwings with termen rounded; dull-reddish, or ochreous-whitish with slight reddish suffusion towards margins; cilia reddish, on dorsum sometimes ochreous-whitish.

Queensland: Charleville in November; North-west Australia: Sherlock River (type in British Museum). Two specimens.

14. Eremonoma zoristis, n.sp.

♂. 30 mm. Head, palpi, thorax, abdomen, and legs whitish. Antennae whitish; pectinations fuscous. Forewings triangular, costa straight to near apex, apex round-pointed, termen scarcely bowed, scarcely oblique; uniformly whitish; cilia whitish. Hindwings with termen rounded; whitish; cilia whitish.

Type in Coll. Goldfinch.

South Australia: Port Augusta in October; one specimen.

15. Eremonoma nephelodes, n.sp.

νεφελώδης, cloudy.

♂. 24 mm. Head and thorax grey mixed with whitish. Palpi 2½; grey. Antennae whitish; pectinations in ♂ 6, grey. Abdomen pale-grey. Legs grey. Forewings triangular, costa straight, apex round-pointed, termen bowed, slightly oblique; whitish-grey, median area grey; an oblique fuscous line from one-sixth costa to one-third dorsum; a dark-fuscous discal spot just beyond middle; a fuscous line from three-fourths costa to two-thirds termen, ill-defined anteriorly; a fine, fuscous, dentate, wavy line from costa near apex, bent inward in disc and continued close to postmedian line to dorsum; cilia whitish-grey. Hindwings with termen rounded; whitish; cilia whitish obscurely barred with grey.

Mr. W. H. T. Tams, who has kindly examined, at my request, the type in the British Museum, informs me that the eyes are densely hairy.

Western Australia: Yallingup; one specimen taken by Mr. R. E. Turner.

16. Eremonoma holopolia, n.sp.

ὁλοπόλιος, wholly grey.

♀. 42 mm. Head, palpi, antennae, thorax, abdomen, and legs grey. Forewings triangular, costa straight to near apex, apex rounded, termen scarcely bowed, oblique; uniformly grey; cilia grey. Hindwings with termen rounded, grey; cilia grey.

Queensland: Clermont in November; one specimen received from Mr. E. J. Dumigan.

5. Genus PORELA.

Wlk., Cat. Brit. Mus., iii., 772. Type, *P. vetusta* Wlk.

Eyes hairy. Palpi short or moderate, not exceeding frontal tuft. Forewings with 2 from before middle of cell, 6 and 7 stalked (rarely connate), 8 separate, connate, or short-stalked, 11 from about middle of cell. Hindwings with cell less than ½; 4 and 5 separate or connate (very rarely short-stalked), 7 from about middle, 11 absent; 12 anastomosing with 7 near its base, subcostal cell moderate, with usually two pseudoneuria, one from near its base, one from beyond middle, but the second may be absent, and rarely there are more than two.

This is a genus of some size with some range of variation in structure, pattern, and coloration.

Key to species.

1.	Forewings with veins more or less ochreous-tinged	2.
	Forewings with veins not ochreous-tinged	5.
2.	Hindwings fuscous	*vetusta*
	Hindwings not fuscous	3.
3.	Forewings without discal spot	*obtusa*
	Forewings with discal spot	4.
4.	Head and thorax white; antennal pectinations blackish	*delineata*
	Head and thorax ochreous-whitish or grey-whitish; antennal pectinations ochreous or ochreous-fuscous	*arida*
5.	Head and thorax white	6.
	Head and thorax not white	8.
6.	Forewings white with suffused fuscous markings	*vitulina*
	Forewings brown with white markings	7.
7.	Forewings with blackish subterminal spots	*subfasciata*
	Forewings with brown subterminal spots edged posteriorly with white	*contermina*
8.	Hindwings fuscous at base	*galactodes*
	Hindwings not fuscous at base	9.
9.	Forewings with postmedian line dark-fuscous	*notabilis*
	Forewings with postmedian line not dark-fuscous	10.
10.	Forewings without antemedian line	*amathodes*
	Forewings with antemedian line	*albifinis*

17. PORELA VETUSTA.

Wlk., Cat. Brit. Mus., iii., 772.—*Perna varia* Wlk., ibid., v., 1128.—*Clathe anthracica* Turn., Trans. Roy. Soc. S. Aust., 1902, 186.

♂. 34-36 mm. ♀. 45-54 mm. Head white; face more or less mixed with ochreous and fuscous. Palpi ochreous mixed with fuscous. Antennae dark-fuscous, stalk ochreous. Thorax dark-fuscous; in ♀ tegulae and patagia white. Abdomen dark-fuscous; tuft white. Legs dark-fuscous; anterior pair barred with ochreous above, clothed with white hair beneath. Forewings elongate-triangular, costa straight in ♂, gently arched in ♀, apex round-pointed, termen slightly bowed, slightly oblique in ♂, more so in ♀; dark-fuscous; in ♂ a small variable white blotch below middle, sometimes nearly obsolete; in ♀ this is much larger and extends from base to postmedian line, where it is acutely angled; a transverse dentate sub-basal line, fuscous edged anteriorly with white; a white median discal dot, sometimes obsolete in ♂; postmedian veins partly outlined with ochreous; a finely dentate, curved line from ⅘ costa to mid-dorsum, usually not very distinct; cilia white barred with fuscous, bases sometimes ochreous.

Hindwings with termen rounded; in ♂ dark-fuscous, in ♀ fuscous; cilia as forewings.

Queensland: Rosewood; New South Wales: Ebor, Barrington Tops, Sydney, Katoomba, Jervis Bay, Mt. Kosciusko; Victoria: Healesville, Dandenong, Moe, Wandin, Gembrook; South Australia: Mt. Lofty, Port Lincoln.

18. PORELA OBTUSA.

Pinara obtusa Wlk., Cat. Brit. Mus., xxxi., 315.—*Opsirhina metastigma* Wlk., ibid., xxxii., 556.—*Mecytha antiqua* Wlk., Char. Undesc. Lep., p. 20.

♂. 34 mm. ♀. 37-40 mm. Head and thorax grey. Palpi grey mixed with fuscous. Antennae fuscous, stalk grey. Abdomen grey; in ♂ suffused with fuscous towards base of dorsum. Legs grey; tarsi fuscous with whitish annulations. Forewings elongate-triangular, costa in ♂ straight, in ♀ arched, apex rounded, termen slightly bowed, in ♂ slightly oblique, in ♀ more strongly so; grey-whitish mixed with grey; a subterminal series of blackish dots, preceded on dorsum by an irregular patch chequered with blackish, and traversed by two short ochreous streaks on veins; cilia pale-grey. Hindwings with termen rounded; grey; cilia grey-whitish.

New South Wales: Sydney.

19. PORELA DELINEATA.

Tacillia delineata Wlk., Cat. Brit. Mus., vi., 1490.

♂. 34-38 mm. ♀. 40-46 mm. Head and thorax white. Palpi dark-fuscous mixed with pale-ochreous. Antennal stalk whitish with some fuscous scales, or wholly fuscous; pectinations blackish. Abdomen whitish; on dorsum mostly fuscous, less so in ♀. Legs usually whitish; tarsi dark-fuscous annulated with pale-ochreous. Forewings triangular, costa straight to near apex in ♂, gently arched in ♀, apex rounded, termen slightly bowed, slightly oblique; whitish irrorated and suffused with fuscous, darker towards costa and base; veins more or less outlined with ochreous; a transverse dentate line from one-third costa to two-fifths dorsum, fuscous edged anteriorly with whitish; a finely denticulate line from two-thirds costa, at first outwardly oblique, then bent strongly inwards ending on mid-dorsum, fuscous, edged posteriorly with whitish; a white discal spot before middle; space between lines suffusedly white towards dorsum; a subterminal series of blackish dots near and parallel to second line; cilia whitish barred with fuscous opposite veins. Hindwings with termen rounded; pale-fuscous, usually with a transverse whitish median band, sometimes almost wholly whitish; cilia as forewings.

Very similar to *P. arida*, but without reddish coloration in hindwings and abdomen, markings of forewings more distinct, head and thorax white, antennal pectinations blackish.

Victoria: Melbourne; South Australia: Port Lincoln.

20. PORELA ARIDA.

Clathe arida Wlk., Cat. Brit. Mus., v., 994.—*Lístoca lignaria* Wlk., ibid., v., 1021.—*Sorema nubila* Wlk., ibid., v., 1065.—*Perna metastigma* Wlk., ibid., xxxii., 477.

♂. 36-42 mm. ♀. 46-60 mm. Head and thorax ochreous-whitish or grey-whitish. Palpi fuscous. Antennal stalk whitish irrorated with fuscous; pectinations ochreous or ochreous-fuscous. Abdomen ochreous-whitish; in ♂ basal three-fourths of dorsum fuscous-red. Legs ochreous-whitish; tarsi whitish or pale-ochreous barred with blackish. Forewings triangular, costa gently arched,

apex rounded, termen bowed, slightly oblique in ♂, more so in ♀, ochreous-whitish, more or less suffused with brownish-ochreous and grey; veins in terminal area more or less ochreous-tinged; a strongly dentate fuscous transverse line from one-third costa to one-third dorsum, sometimes obsolete; a white, median, discal dot; a fuscous line from three-fourths costa, at first very acutely dentate and transverse, then bent sharply inwards and shortly dentate to mid-dorsum, usually distinct, sometimes faint; a fuscous suffused patch on dorsum posterior to this line; a subterminal series of fuscous dots suffusedly edged with whitish, sometimes elongate, sometimes nearly obsolete; cilia ochreous-whitish with fuscous bars, but these are sometimes obsolete in ♀. Hindwings with termen rounded; in ♂ fuscous-reddish, in ♀ ochreous-whitish with slight brownish or grey suffusion; cilia as forewings.

Northern Territory: Stapleton; North Queensland: Prince of Wales Is., Cairns, Ingham, Townsville; Queensland: Duaringa, Brisbane; New South Wales: Lismore, Sydney, Jervis Bay.

21. Porela vitulina.

Bombyx vitulina Don., Ins. New Holl., Pl. 35.

♂. 48-50 mm. ♀. 64 mm. Head white; face ochreous-tinged with a median transverse fuscous line. Palpi dark-fuscous, apical third ochreous. Antennae ochreous-fuscous, stalk whitish irrorated with fuscous. Thorax white; a central fuscous longitudinal line diverging into a broad V at each extremity. Legs fuscous annulated with ochreous; anterior tibiae with ventral hairs white. Forewings triangular, costa straight to near apex, apex rounded, termen slightly bowed, in ♂ slightly oblique, in ♀ more strongly so; white with some patchy fuscous suffusion and fuscous markings; a basal patch; a broad, outwardly-curved, transverse line at ⅓; a median, white-centred, discal spot; a broad line from beyond mid-costa, at first transverse, then oblique to mid-dorsum, with a posterior tooth above and another below middle; a twice-sinuate, dentate, subterminal line; a terminal suffusion; cilia white with fuscous bars. Hindwings with termen rounded; fuscous with suffused, transverse, median and subterminal, paler fasciae; cilia as forewings.

Queensland: Brisbane, Southport, Coolangatta; New South Wales: Newcastle; Victoria: Melbourne.

22. Porela subfasciata.

Sinaga subfasciata Wlk., Cat. Brit. Mus., iv., 855.—*Bombyx barnardi* Luc., Trans. Nat. Hist. Soc. Q'ld., i., 104.

♂. 34 mm. ♀. 44-50 mm. Head and thorax white, more or less suffused with brown. Palpi white with dark-fuscous hairs from base. Antennae dark-fuscous. Abdomen fuscous-brown; tuft paler. Legs brown-whitish; tarsi dark-fuscous annulated with white. Forewings triangular, costa straight to near apex, apex rounded, termen straight, in ♂ not oblique, in ♀ slightly so; fuscous-brown; an outwardly-curved, broad, white, sub-basal, transverse line to near dorsum, where it curves inwards towards base; a white median discal spot; a sinuate line from ⅔ costa to mid-dorsum; a suffused white subterminal fascia preceded below costa and on dorsum, interrupted in middle, and partly edged posteriorly, by blackish spots; cilia fuscous brown. Hindwings with termen rounded; fuscous-brown, in ♀ paler; cilia white.

New South Wales: Bathurst; Tasmania: Ulverstone, Georgetown.

23. Porela galactodes.

Bombyx galactodes Low., Trans. Roy. Soc. S. Aust., 1893, 151.

♂. 44-46 mm. ♀. 68 mm. Head, palpi, thorax, and abdomen in ♂ dark-fuscous, in ♀ fuscous. Antennae brownish, stalk fuscous. Legs fuscous; tarsi annulated with white. Forewings triangular, costa straight to near apex, apex rounded, termen bowed, oblique; white generally suffused or irrorated with fuscous, more densely so towards base and between first and second lines, whiter in costal area between second and third lines; an outwardly-curved, dark-fuscous sub-basal line curved inwards towards base of dorsum; an antemedian, pale-centred discal spot; a dark-fuscous line irregularly dentate with a posterior tooth above middle, from or from beyond mid-costa to mid-dorsum; a finely dentate subterminal line indented beneath costa; cilia fuscous. Hindwings with termen rounded; in ♂ dark-fuscous with a white terminal band, interrupted on veins, and not quite reaching tornus; in ♀ whitish, basal area and a postmedian line fuscous; cilia fuscous.

Queensland: Duaringa, Clermont; Victoria: Kewell, Birchip. In a ♂ example from the last locality the terminal white band of hindwings is broader and more suffused, and the apices of palpi are whitish. In the ♀ from Kewell the hindwings are almost wholly grey-whitish. This form is a local race of *galactodes;* it has been known as *homospila* Meyr., but I do not think that name has been published.

24. Porela notabilis.

Teara notabilis Wlk., Cat. Brit. Mus., iv., 852.—*Cosmotricha notodontina* Feld., Reise Nov., Pl. 84, f. 11.—*Bombyx mioleuca* Meyr., Trans. Roy. Soc. S. Aust., 1891, 190.

♂. 43 mm. ♀. 56 mm. Head, palpi, and thorax fuscous or grey. Antennae fuscous or grey; pectinations ochreous-tinged, in ♂ 12, in ♀ 2½. Abdomen grey. Legs fuscous or grey. Forewings elongate-triangular, costa straight nearly to apex in ♂, straight to two-thirds in ♀, apex rounded, termen slightly bowed, oblique; grey; a basal fuscous patch in ♂; a dark-fuscous, straight, sub-basal, transverse line, edged anteriorly with whitish; a whitish discal spot before middle, edged with fuscous, slightly reniform; a thick dark fuscous line from three-fifths costa obtusely angled outwards in disc, then curved inwards, bent outwards again to end on three-fifths dorsum, edged posteriorly with whitish; a subterminal series of whitish spots, or in ♀ a subterminal whitish suffusion containing a suffused wavy dark line; cilia grey, apices whitish, with fuscous bars opposite veins. Hindwings with termen strongly rounded; whitish; cilia whitish.

Described from two examples including the type in the British Museum. Three examples in my own collection have the discoidal spot almost circular.

New South Wales: Bourke; Victoria: Birchip, Kewell; South Australia: Adelaide; Western Australia: Northam, Kalgoorlie.

25. Porela amathodes, n.sp.

ἀμαθώδης, sandy.

♂. 32 mm. Head, palpi, thorax, and abdomen pale brownish. Antennae brown-whitish; pectinations in ♂ 12. Legs pale brownish. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen bowed, scarcely oblique; pale brownish with slight fuscous irroration in cell and on veins; a pale discal spot before middle in darker area; a double fuscous line with a contained pale line from ⅔ costa to mid-dorsum, rounded in disc, sinuate above

dorsum; cilia brownish mixed with fuscous. Hindwings with termen strongly rounded; ochreous-whitish; cilia ochreous-whitish.

Differs from other species of *Porela* in having 6 and 7 of the forewings connate not stalked.

N.W.A.: Sherlock River; one specimen in the British Museum.

26. Porela albifinis.

Callia albifinis Wlk., Cat. Brit. Mus., vi., 1483.

♂. 32-42 mm. ♀. 48 mm. Head, palpi, brown. Antennae brown mixed with whitish; pectinations pale-ochreous, in ♂ 12, in ♀ 2. Thorax brown, tips of hairs whitish; posteriorly fuscous. Abdomen white; basal segments fuscous on dorsum. Legs brown. Forewings elongate-triangular, costa straight nearly to apex, apex rounded, termen bowed, slightly oblique; brown, somewhat reddish tinged or fuscous-brown; a whitish transverse line near base with a sharp posterior tooth beneath costa; a white median discal spot, outlined with blackish, more or less reniform; a wavy whitish line from two-thirds costa to two-thirds dorsum; a whitish subterminal shade containing a dentate dark line; cilia brown or fuscous-brown. Hindwings with termen strongly rounded; whitish; cilia whitish.

Described from three examples including the type in the British Museum.

New South Wales: Sydney; Victoria: Melbourne; Tasmania: Hobart, Launceston.

27. Porela contermina.

Callia albifinis ♀. Wlk., Cat. Brit. Mus., vi., 1483.—*Callia contermina* Wlk., Cat. Brit. Mus., xxxii., 572.

♀. 39 mm. Head whitish; sides of face dark-fuscous. Palpi 3; dark-fuscous. Antennae dark-fuscous; pectinations in ♀ 1. Thorax whitish. Abdomen brown, tuft whitish. Legs fuscous with long whitish hairs; tarsi fuscous annulated with whitish. Forewings elongate-triangular, costa straight to two-thirds, thence gently arched, apex round-pointed, termen bowed, oblique; brown; markings white; a median basal spot; a fine, wavy, slightly outwardly-curved line from one-sixth costa to one-sixth dorsum; a median discal spot; a finely dentate, outwardly-curved line from two-thirds costa to dorsum beyond middle; a series of rather large dark-brown spots from apex to tornus, finely edged posteriorly with white; cilia white, apices and bars opposite veins brown. Hindwings with termen strongly rounded; brown, paler near base; cilia brown, bases partly whitish.

Allied to *P. albifinis*, but structurally peculiar in having four pseudoneuria from subcostal cell, two before and two after middle. The description is taken from the British Museum type, which is from Tasmania.

6. Genus Symphyta.

Turn., Trans. Roy. Soc. S. Aust., 1902, 187. Type, *S. psaropis* Turn.

Eyes hairy. Palpi short, not extending beyond frontal tuft. Forewings with 2 from one-third, 3 from two-thirds, 6, 7, 8 stalked. Hindwings with cell ¼ to one-third; 2 from shortly before angle, 4 and 5 stalked from angle, 3 separate, connate, or short-stalked, 7 from near base, 11 absent, 12 anastomosing with 7 near its base; subcostal cell small, with two strong sometimes branching pseudoneuria, one from base, the other from middle.

Key to species.

1.	Forewings with an oblique postmedian line	*oxygramma*
	Forewings without postmedian line	2.
2	Forewings with termen strongly sinuate in ♂	*colpodes*
	Forewings with termen not sinuate	3.
3.	Wings fuscous	*nyctopis*
	Wings whitish-grey	*psaropis*

28. Symphyta oxygramma.

Bombyx oxygramma Low., Trans. Roy. Soc. S. Aust., 1902, 213.

♂. 34-36 mm. ♀. 42 mm. Head, palpi, thorax, and abdomen fuscous or grey. Antennae dark-fuscous. Legs fuscous. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen slightly bowed, oblique; whitish with general dense fuscous irroration, appearing grey; a fuscous discal dot before middle on end of cell; a finely dentate fuscous line from beneath apex to two-thirds dorsum, more or less edged with whitish anteriorly; cilia grey-whitish barred with fuscous. Hindwings with termen rounded; grey-whitish; cilia as forewings.

An inland species.

Queensland: Jandowae; New South Wales: Bourke, Broken Hill; South Australia: McDouall Peak; Western Australia: Quairading, Merredin.

29. Symphyta colpodes, n.sp.

κολπώδης, sinuate.

♂. 36 mm. Head, palpi, antennae, thorax, abdomen and legs fuscous. Forewings elongate-triangular, costa straight to near apex, there strongly arched, apex pointed, termen strongly sinuate, oblique; fuscous with general whitish irroration, appearing dark-grey; a whitish median discal spot; most veins outlined with fuscous; cilia fuscous, apices white except opposite veins. Hindwings with termen rounded; fuscous; cilia as forewings.

Western Australia: Cunderdin in November; one specimen received from Mr. R. Illidge.

30. Symphyta nyctopis.

Turn., Trans. Roy. Soc. S. Aust., 1902, 187.

North Queensland: Townsville; Queensland: Emerald, Jandowae; Victoria: Sea Lake. Apparently confined to dry districts.

31. Symphyta psaropis.

Turn., Trans. Roy. Soc. S. Aust., 1902, 187.

North Queensland: Cairns, Townsville; Queensland: Gayndah.

7. Genus Cyclophragma.

Turn., Ann. Q'ld. Mus., x., 1911, 94. Type, *C. cyclomela* Low.

Eyes smooth. Palpi short, not reaching beyond frontal tuft. Forewings with 2 from one-third, 3 from two-thirds, 6 and 7 stalked, 8 separate, 11 from two-thirds. Hindwings in ♂ elongate; cell about ½; 2 from shortly before angle, 4 and 5 stalked, 7 from about middle, 11 absent, 12 anastomosing very shortly with 7 after its origin; subcostal cell moderately large, a strong pseudoneurium from its base, and some very weak indications of additional pseudoneuria.

32. CYCLOPHRAGMA CYCLOMELA.

Opsirhina cyclomela Low., Trans. Roy. Soc. S. Aust., 1903, 183.

♂. 60-66 mm. Head and thorax pale-ochreous-grey. Palpi fuscous irrorated with grey. Antennae greyish ochreous with some fuscous scales. Abdomen ochreous with lateral series of large blackish marks on each segment, approximated but not meeting dorsally; tuft and underside grey. Legs grey; anterior pair fuscous; tarsi annulated with whitish. Forewings suboval, costa strongly arched, apex rounded, termen nearly straight, oblique; pale-ochreous-grey with some fuscous irroration; a small ochreous tuft of hairs on base of dorsum; five, wavy, or crenulate, fuscous, transverse lines; first slender, sub-basal; second at one-sixth; third at one-third, stronger towards costa; fourth beyond middle stronger towards costa; fifth at two-thirds, faintly marked; a minute white discal dot posterior to third line; a subterminal series of blackish dots; cilia grey. Hindwings strongly elongate, termen rounded; grey, almost wholly suffused with fuscous, but apical area free from suffusion and crossed by two fuscous lines; extreme base with ochreous hairs; cilia fuscous-grey, apices whitish.

♀. 90-110 mm. Forewings similar, but transverse lines very faintly indicated; no basal tuft on dorsum. Hindwings not elongate; uniformly grey, except for a slight ochreous tinge at base. Abdomen uniformly grey.

North Queensland: Cooktown, Townsville, Mackay.

8. Genus ENTOMETA.

Wlk., Cat. Brit. Mus., iv., 972. Type, *E. marginata* Wlk.

Eyes smooth, large, rather smaller in ♀. Palpi very long, porrect, much exceeding frontal tuft. Forewings elongate; 2 from one-third; 3 from two-thirds, 6 and 7 stalked, 8 connate or separate, 11 from middle. Hindwings with cell less than ½; 2 from before angle, 4 and 5 stalked, 3 connate or short-stalked, 7 from one-third, 11 absent, 12 anastomosing very shortly with 7 near its origin; subcostal cell moderate, with basal and median pseudoneuria, the former often obsolete.

Distinguished from the following genus by its large smooth eyes. The species are closely allied and require careful discrimination.

Key to males.

1. Hindwings blackish with orange terminal band .. .. *marginata*
   Hindwings not so .. .. 2.
2. Hindwings fuscous or dark-reddish .. .. *fervens*
   Hindwings orange .. .. 3.
3. Hindwings with more or less fuscous suffusion in basal two-thirds *apicalis*
   Hindwings without basal fuscous suffusion .. .. 4.
4. Forewings with transverse lines and dark irroration more or less developed .. 5.
   Forewings pale, without lines and irroration .. .. *albida*
5. Forewings with conspicuous, broad, suffused lines .. .. *guttularis*
   Forewings with lines very slender, inconspicuous, not suffused .. . 6.
6. Forewings narrowly triangular, apex pointed .. .. *sobria*
   Forewings broad, apex more rounded .. .. *chlorosacca*

It does not seem possible to construct a satisfactory key for the females, but the following characters will be found helpful. The female *albida* is very

similar to the ♂, and has no irroration nor markings except a discal dot on the forewings. The female *marginata* I have not seen. *E. fervens* has sometimes a dusky suffusion, which is never present in other species, and very often a dark suffusion across hindwings, which is absent in *sobria* and *chlorosacca*. It is smaller than *sobria*, the forewings have the ground colour more whitish, and the transverse lines are more distinct; *apicalis* is very like *sobria;* but often larger, the hindwings more deeply orange, and with a suffused median transverse darker shade; *guttularis* is readily distinguished by the broad dark transverse lines on forewings; *chlorosacca* has the lines on forewings very slightly, if at all, developed, contrasting with the well-marked discal spot.

E. sobria and probably other species spin an oval whitish cocoon, as found in other genera; *chlorosacca* is conspicuously distinct by its oval cocoon of a bright green colour, which is unique, so far as I know, in the Lepidoptera. The cocoon of *apicalis* is brown, and quadrangular from the longitudinally arranged narrow leaves, which are incorporated with it. More knowledge of the early stages of these and other species is needed. The possibility cannot at present be excluded, that *guttularis* may be a varietal form of *sobria*, and that both may be a local race of *fervens;* I think, however, they are good species.

33. Entometa marginata.

Wlk., Cat. Brit. Mus., iv., 972.

♂. 55-60 mm. Head and thorax brown with fine orange irroration. Palpi 2½; brown. Antennae fuscous-brown. Abdomen blackish. Legs brown. Forewings narrowly triangular, costa straight to near apex, apex rounded, termen sinuate, strongly excavated in middle, strongly oblique; brown densely irrorated with orange; three transverse fuscous lines; first from one-fifth costa to one-fifth dorsum, outwardly curved and dentate; an obscure fuscous dot on end of cell at ⅓; second line from two-thirds costa to dorsum before middle, finely waved; third from ⅔ dorsum, parallel to termen, wavy, becoming obsolete towards costa; cilia brown. Hindwings with termen rounded; 4 and 5 short-stalked; blackish; an orange terminal band not quite reaching apex and tornus, sharply defined, its anterior border dentate; cilia orange, on apex and dorsum blackish.

I do not know the ♀ of this species.

Victoria: Melbourne, Gisborne; Tasmania: —— ——.

34. Entometa fervens.

♀. *Opsirhina fervens* Wlk., Cat. Brit. Mus., vi., 1419.—♂. *Lebeda obscura* Wlk., ibid., vi., 1464.—♂. *Lebeda saturata* Wlk., ibid., xxxii., 569.—♂. *Entometa despecta* Wlk., Char. Undesc. Lep., p. 66.

♂. 44-64 mm. Head and thorax pale-ochreous usually finely irrorated with reddish or fuscous. Palpi 2½ to 3; fuscous with more or less pale-ochreous irroration. Antennae fuscous; pectinations ochreous-tinged. Abdomen fuscous or fuscous-reddish; paler beneath. Legs brownish. Forewings narrowly triangular, costa straight to near apex, apex pointed, termen sinuate, oblique; pale-ochreous with more or less fine reddish or fuscous irroration, sometimes dense; lines slender, fuscous; first from ¼ costa, slightly angled posteriorly beneath costa, not reaching dorsum; a fuscous discal mark on end of cell before middle; second line from ⅔ costa to mid-dorsum, nearly straight, obscurely denticulate; third from beneath costa near apex to about ¾ dorsum, interrupted to form a series of inter-neural dots; cilia concolorous. Hindwings with termen rounded;

3 connate or short-stalked; dark-fuscous, usually reddish-tinged towards dorsum and base, or wholly reddish; cilia concolorous. Underside of forewings reddish-ochreous; towards apex and termen ochreous-grey; first and third lines obsolete, second developed; of hindwings ochreous-grey with a large dorsal fuscous or reddish suffusion, from which two fuscous lines proceed to costa beyond middle.

♀. 66-75 mm. Palpi 5. Forewings broader, costa arched, apex more rounded, termen bowed; whitish-ochreous, occasionally with fuscous irroration towards termen; lines as in ♂, but more distinct and sometimes reddish. Hindwings orange; often with a fuscous or reddish, transverse, median suffusion.

Walker's type is a ♀ from Sydney, with an indistinct darker band across forewings. One ♀ from Melbourne has the hindwings fuscous-brown.

New South Wales: Newcastle, Sydney, Broken Hill; Victoria: Melbourne; Tasmania: Launceston; South Australia: Adelaide, Mt. Lofty.

35. ENTOMETA APICALIS.

♂. *Lebeda apicalis* Wlk., Cat. Brit. Mus., vi., 1464.

♂. 66-75 mm. Head and thorax ochreous or reddish-ochreous. Palpi 2½; brown. Abdomen fuscous or brown; paler beneath. Legs fuscous or brown. Forewings triangular, costa straight to near apex, apex rounded, termen slightly sinuate oblique; pale-ochreous with more or less fine reddish-brown irroration; markings fuscous-brown; first line from one-fifth costa, angled outwards above and below middle, obsolete towards dorsum; a discal dot at one-third; second line from two-thirds costa to mid-dorsum, denticulate; third line from beneath costa near apex to ¾ dorsum, interrupted on veins to form a series of anteriorly curved lunules; cilia concolorous. Hindwings with termen strongly rounded; 3 connate with 4, 5; orange, basal two-thirds more or less suffused with fuscous-brown; cilia ochreous or orange. Underside of forewings with second and third lines developed; of hindwings ochreous-grey with a transverse fuscous antemedian line.

♀. 80-122 mm. Palpi 5. Coloration as in ♂, but abdomen pale-ochreous; hindwings with 3 separate or connate; orange with usually a faint, darker, median, transverse shade. Forewings with costa arched, termen slightly bowed; markings similar but less distinct.

The ♂ is easily recognised by its larger size, broader, pale forewings with distinct but slender lines and dichroic hindwings. The ♀ is very similar to *E. fervens*.

Queensland: Mt. Tambourine; New South Wales: Sydney; Victoria: Melbourne, Gisborne, Birchip; Tasmania: Launceston; South Australia: Murray Bridge.

36. ENTOMETA GUTTULARIS.

♀. *Amydona guttularis* Wlk., Cat. Brit. Mus., vi., 1413.—♀. *Opsirhina decorata* Wlk., ibid., xxxii., 555.

♂. 55 mm. Head and thorax brownish-ochreous. Palpi 3; fuscous-brown. Antennae dark-fuscous; pectinations ochreous. Abdomen brownish-ochreous. Legs brown. Forewings narrow, triangular, costa straight to near apex, apex roundpointed, termen slightly sinuate, oblique; pale-ochreous with brown irroration and markings; a basal costal spot; three stout transverse lines very distinctly developed, suffused and more or less confluent towards dorsum; first from ¼ costa to ¼ dorsum, acutely angled posteriorly beneath costa; a transverse mark on end of cell at two-fifths; second line from two-thirds costa to before mid-

dorsum, nearly straight, wavy; third line from beneath costa near apex to two-thirds dorsum, broadly suffused and confluent with second line in dorsal half, posterior edge sinuate and subdentate; a narrow terminal suffusion; cilia brown. Hindwings with termen strongly rounded; 3 stalked with 4, 5 or separate; orange; a small brown costal suffusion; cilia brown. Underside paler; forewings with second and third lines only; hindwings with two short lines from costa beyond middle.

♀. 170-172 mm. Coloration similar but paler. Palpi 4. Forewings broader, termen slightly bowed; markings strongly developed, but first line does not reach dorsum, discal mark at one-third; second and third lines much less suffused. Hindwings with 3 separate or connate.

This species is easily recognised, but, until the early stages are known, its distinctness from *E. fervens* will not be established. Walker erroneously gave the locality of his type of *guttularis* as South Africa.

Queensland: Brisbane.

37. Entometa sobria.

♀. *Opsirhina sobria* Wlk., Cat. Brit. Mus., xxxii., 556.—♂♀. *O. flexicosta* Feld., Reise Nov., Pl. 84, f. 4, 5.

♂. 52-58 mm. Head and thorax fuscous-reddish, usually finely irrorated with pale-ochreous. Palpi 3 to 3½; fuscous, irrorated with pale-ochreous. Antennae fuscous; pectinations ochreous-tinged. Abdomen pale-ochreous more or less suffused with fuscous-brown. Legs brown. Forewings rather narrow, triangular, costa straight to near apex, apex round-pointed, termen sinuate, oblique; pale-ochreous, more or less irrorated with reddish-fuscous, or rarely reddish with slight pale-ochreous irroration; transverse lines fuscous, very slender, often obscure or partly obsolete; first line from ¼ costa, angled posteriorly beneath costa, not reaching dorsum, sometimes obsolete; sometimes a slight discal mark at two-fifths; second line from ⅔ costa to mid-dorsum, sometimes denticulate; third line obsolete, or represented by a few spots only; cilia concolorous. Hindwings with termen strongly rounded; 3 connate or short-stalked; orange; a reddish-grey costal blotch; at base, dorsum, and sometimes termen narrowly pale-ochreous; cilia ochreous, sometimes mixed with brown. Underside of forewings grey, more or less orange-tinged in centre, second line well-developed, but not reaching dorsum; of hindwings grey, with a large whitish-ochreous dorsal blotch connected with mid-costa by a short fuscous line.

♀. 82-104 mm. Palpi 3 to 3½. Forewings broader, costa arched, apex rounded, termen bowed; whitish-ochreous with very slight brownish irroration; lines very slender, but better marked than in ♂; third line represented by a series of spots. Hindwings pale-orange.

Walker's type is a ♀ from Brisbane.

North Queensland: Cardwell; Queensland: Brisbane, Toowoomba; New South Wales: Lismore; Victoria: Melbourne, Brentwood, Kewell; Western Australia: Albany, Perth.

38. Entometa chlorosacca, n.sp.

χλωροσακκος, with green sack.

♂. 60-75 mm. Head and thorax pale-ochreous, sometimes reddish-tinged. Palpi 2½ to 3; fuscous with some pale-ochreous irroration. Antennae fuscous; pectinations sometimes ochreous-tinged. Abdomen ochreous-grey or ochreous-whitish. Legs brownish or grey. Forewings moderately broad, triangular, costa

straight to near apex, apex rounded, termen slightly sinuate, oblique; whitish, more or less densely irrorated with reddish-brown; lines fuscous or reddish, sometimes distinct, sometimes very slender, partly obsolete; first line from ¼ costa, slightly angled posteriorly beneath costa, not reaching dorsum; a small discal dot or mark; second line from ⅔ costa to mid-dorsum, sometimes denticulate; third line obsolete; cilia concolorous. Hindwings with termen rounded; 3 connate; orange; sometimes grey on costa and part of termen, and pale-ochreous on base and dorsum; cilia orange or brownish, apices whitish. Underside grey; of forewings orange-tinged; second line of forewings developed; hindwings with a short transverse fuscous line from mid-costa.

♀. 66-98 mm. Forewings rather paler, costa arched, termen bowed; all lines obsolete, or with second line faintly indicated, sometimes also an interrupted third line and very rarely any first line, but a well-marked reddish discal spot. Hindwings pale-orange.

Northern Territory: Darwin; New South Wales: Newcastle; Victoria: Melbourne, Kewell, Inglewood; South Australia: Adelaide; Western Australia: Cunderdin; North West Australia: Derby.

The type is a ♀ in the South Australian Museum. I have seen only three examples certainly bred from green cocoons, and all of this sex.

39. Entometa albida.

Opsirhina albida Wlk., Cat. Brit. Mus., xxxii., 557.—*Pinara erubescens* Low., Trans. Roy. Soc. S. Aust., 1894, 77.

♂. 54 mm. Head, thorax, and abdomen pale-ochreous. Palpi 2½; fuscous, inner surface pale-ochreous. Antennae fuscous. Legs purple-fuscous; coxae pale-ochreous. Forewings narrowly triangular, costa straight, slightly arched beyond middle, apex round-pointed, termen doubly sinuate, concave in middle, strongly oblique; pale-ochreous becoming paler towards termen; a fuscous-brown discal dot on end of cell; cilia concolorous. Hindwings rather elongate, termen strongly rounded; pale-ochreous, paler near termen; cilia concolorous.

♀. 80 mm. Similar to ♂, but considerably paler. Forewings broader, costa moderately arched, termen slightly bowed. Palpi 2½.

Queensland: Duaringa, two specimens from the Miskin Collection in the Queensland Museum; New South Wales: Warangesda.

9. Genus Diggllesia.

Turn., Ann. Q'ld. Mus., x., 1911, 86. Type, *D. crocota* Turn.

Eyes hairy. Palpi long or very long, porrect, exceeding frontal tuft. Forewings with 2 from or from before middle, 6 and 7 stalked, 8 separate, connate, or rarely stalked, 11 from middle; cell one-third to ½. Hindwings with cell about one-third; 2 from before angle, 4 and 5 stalked, 3 separate, connate, or stalked with them, 7 from before middle, 11 absent, 12 anastomosing shortly with 7 near its origin, subcostal cell moderate, with one or two pseudoneuria from near its middle.

A natural genus with some variability in its neuration.

Key to species.

1.	Forewings white with fuscous markings	*ecnoma*
	Forewings not white	2.
2.	Cilia of forewings with whitish apices	3.

	Cilia of forewings with apices not whitish	4.
3.	Forewings with discal spot; hindwings wholly or partly ochreous	*dasymalla*
	Forewings without discal spot; hindwings reddish or fuscous	*rufescens*
4.	Wings grey	5.
	Wings reddish	6.
5.	Wings ochreous-grey-whitish	*spodopa*
	Wings darker grey without ochreous tinge	*tephropsis*
6.	Forewings with first and second lines confluent on dorsum	*crocota*
	Forewings with first and second lines separate or obsolete	7.
7.	Size small; colour dark-reddish	*nana*
	Size moderately large; colour pale-reddish or reddish-ochreous	8.
8.	♂ with palpi 4, hindwings elongate; ♀ with apex of forewings rounded	*cycloloma*
	♂ with palpi 6, hindwings not elongate; ♀ with apex of forewings pointed	*australasiae*

40. Digglesia ecnoma, n.sp.

ἔκνομος, unusual.

♀. 55 mm. Head whitish. Palpi and antennae blackish. Thorax dark-fuscous mixed with reddish-ochreous and crossed by a transverse line of whitish hairs. Abdomen on dorsum ochreous, sides and under surface fuscous with apices of segments whitish. Legs fuscous; dorsal hairs whitish. Forewings elongate-triangular, costa gently arched, apex rounded, termen slightly bowed, oblique; cell one-third, 8 connate; white with well-defined dark-fuscous markings; a narrow basal fascia; a second fascia at one-fifth, connected with preceding on dorsum; a large discal spot at one-third; a narrow fascia from three-fifths costa to mid-dorsum sinuate, anteriorly crenated, connected with preceding by a submedian bar, a broader fascia also sinuate, but interrupted by veins, at four-fifths; a terminal series of large spots; cilia dark-fuscous, interrupted by whitish opposite veins. Hindwings with termen rounded; 3 connate; colour as forewings; broadly suffused, transverse, fuscous fasciae at ¼ and middle; a terminal series of fuscous spots; cilia whitish.

Very different from any other known species.

Western Australia: Cunderdin, one specimen reared from the larva in March, received from Mr. W. B. Alexander.

41. Digglesia dasymalla, n.sp.

δασύ-μαλλος, thick-fleeced.

♂. 44-48 mm. Head, palpi, and thorax ochreous-brown. Antennae fuscous-brown, stalk ochreous brown. Abdomen and legs brownish-ochreous. Forewings broadly triangular, costa straight to near apex, apex rounded-rectangular, termen straight, scarcely oblique; cell one-third, 8 separate; rather dark ochreous-brown; a small fuscous discal spot at one-third on end of cell; cilia ochreous-brown, apices except opposite veins whitish. Hindwings with termen rounded; 3 separate; brownish-ochreous; cilia brownish-ochreous, apices partly whitish.

♀. 64 mm. Neuration as in ♂. Colour uniformly fuscous, slightly ochreous-suffused only on bases of hindwings. Abdomen with terminal and lateral tufts extremely dense. Forewings broadly triangular, costa arched, termen slightly bowed, slightly oblique; discal spot very obscure. Hindwings with veins narrowly ochreous.

Type in Coll. Goldfinch. This and the following have the abdomen very hairy laterally as well as posteriorly.

New South Wales: Mount Kosciusko (5000 ft.) in December; three specimens received from Mr. G. M. Goldfinch. The males were taken flying swiftly in bright sunshine, the female at light at the hotel. The sexual dichroism, exceptional in this genus, is probably correlated with the day flying habit.

42. DIGGLESIA RUFESCENS.

Gastropacha rufescens Wlk., Cat. Brit. Mus., vi., 1395.—*Megasoma rubida* Wlk., ibid., xxxii., 566.—*Bombyx crenulata* Luc., Proc. Linn. Soc. N.S.W., 1893, 137.

♂. 38-46 mm. ♀. 55-66 mm. Head, thorax, and abdomen grey, usually more or less reddish-tinged. Palpi 4 to 5; grey or reddish-grey. Antennae grey; pectinations in ♂ ochreous-tinged. Legs grey. Forewings triangular, costa slightly arched, apex rounded-rectangular, termen slightly sinuate, slightly waved, in ♂ scarcely oblique, in ♀ more distinctly so; cell one-third, 8 separate (1 ♂), connate (4 ♂, 5 ♀) or short-stalked (1 ♀); grey, usually more or less reddish-tinged; sometimes a fuscous dot on end of cell at one-third; cilia concolorous, apices whitish between veins. Hindwings with termen strongly rounded; 3 separate, 4 and 5 stalked; colour and cilia as forewings.

Queensland: Brisbane, Stradbroke Island, Mt. Tambourine; New South Wales: Sydney, Jervis Bay, Mt. Kosciusko; Victoria: Melbourne, Beaconsfield, Gisborne, Mt. St. Bernard; Tasmania: Hobart; South Australia: Mt. Lofty.

43. DIGGLESIA SPODOPA.

Entometa spodopa Turn., Trans. Roy. Soc. S. Aust., 1904, 239.

Forewings with cell nearly ½, 8 connate or stalked. Hindwings with 3 connate or stalked.

Queensland: Brisbane.

44. DIGGLESIA TEPHROPSIS, n.sp.

τεφροχις, ash-coloured.

♀. 50 mm. Head and thorax pale-grey. Palpi 8; expanded at apices; pale-grey. Antennae, abdomen, and legs pale-grey. Forewings elongate-triangular, costa arched, apex rectangular, termen bowed, strongly oblique; cell nearly ½, 8 connate; pale-grey; a fuscous discal dot at two-fifths; a faintly-marked subterminal series of interneural fuscous dots; cilia grey. Hindwings with termen rounded; cell one-third, 3 connate; dark-grey becoming paler towards base; cilia grey.

Allied to *D. spodopa*, but darker grey without ochreous tinge, and without first and second lines on forewings.

Queensland: Emerald in September; one specimen received from Mr. W. B. Barnard.

45. DIGGLESIA CROCOTA.

Turn., Ann. Q'ld. Mus., x., 1911, 86.

♀. 54-56 mm. Head and thorax orange-brown. Palpi 6; somewhat expanded at apex; grey. Antennae pale-ochreous. Abdomen ochreous-brown; underside darker. Legs brown. Forewings suboval, costa strongly arched, apex rectangular, termen nearly straight, moderately oblique; cell two-fifths, 6, 7, 8 stalked (2 ♀); reddish-ochreous; markings fuscous; a nearly straight, wavy line from one-third costa to one-third dorsum; a discal dot at one-third between lines; second line wavy, from mid-costa, curved inwards to join first line on dorsum;

an interrupted line, or chain of dots, from costa near apex to two-thirds dorsum, angled obtusely outwards below middle; cilia orange-brown. Hindwings with termen strongly rounded; 3, 4, 5 stalked; pale-reddish; cilia rather paler. Underside of hindwings with a very large dark blotch bisected by a darker line.

North Queensland: Kuranda near Cairns, Cardwell.

46. Digglesia nana.

Opsirhina nana Wlk., Cat. Brit. Mus., vi., 1421.

♂. 25-28 mm. Head and thorax reddish. Palpi 6; reddish. Antennae pale-grey, reddish-tinged; pectinations fuscous. Abdomen fuscous; underside ochreous-reddish. Legs reddish. Forewings triangular, costa straight nearly to apex, apex pointed, termen straight, oblique; cell ½, 8 connate; uniformly reddish; a fuscous discal dot at ½; a slender, oblique, dark line from two-thirds costa to dorsum beyond middle; traces of a similar subterminal line; cilia reddish. Hindwings with termen rounded; cell ¼ to one-third, 3 connate or stalked; dark-reddish with a fuscous subdorsal suffusion; cilia dark-reddish.

♀. Unknown.

Much smaller than any other species.

Tasmania: Launceston, Lefroy.

47. Digglesia cycloloma.

Entometa cycloloma Turn., Trans. Roy. Soc. S. Aust., 1902, 186.—*E. plinthopa* Turn., ibid., 1904, 239.

Forewings with cell nearly ½, 8 connate or stalked. Hindwings with 3 connate or stalked.

Northern Territory: Darwin; North Queensland: Cooktown, Cairns, Townsville; Queensland: Nambour, Mt. Tambourine, National Park (4000 ft.); New South Wales: Lismore; Victoria: Moe.

48. Digglesia australasiae.

Bombyx australasiae Fab., Syst. Ent., iii. (1), 422.—*Opsirhina nasuta* Wlk., Cat. Brit. Mus., vi., 1420.—*O. intemerata* Wlk., ibid., xxxii., 557.—*O. cinereata* Wlk., ibid., xxxii., 558.—*O. pudorina* Wlk., ibid., xxxii., 558.—*Bombyx frugalis* Luc., Proc. Roy. Soc. Q'ld., 1901, 74.—*Pinara pervicax* Luc., ibid., 1901, 76.

♂. 32-36 mm. Eyes small. Palpi very long, more than twice length of frontal tuft. Head, palpi, antennae, thorax, abdomen, and legs ochreous-reddish. Forewings oval-triangular, costa straight to near apex, apex rounded, termen bowed, oblique; cell ½, 8 connate or stalked; reddish-ochreous; two faintly marked transverse lines, darker than ground colour, but edged with paler ochreous; first from one-third costa, strongly outwardly curved to near base of dorsum, pale anteriorly; second from two-thirds costa, curved outwardly beneath costa, thence straight to about mid-dorsum, pale posteriorly; a minute dark discal dot before middle; a subterminal series of dark dots forming a nearly straight line; cilia concolorous. Hindwings with termen rounded; 3 connate or stalked; reddish, rather darker than forewings; cilia concolorous.

♀. 42-52 mm. Wings much more elongate; forewings narrow, apex tolerably pointed; markings sometimes distinct, but often obsolete.

Queensland: Clermont, Brisbane, Rosewood, Toowoomba; New South Wales: Lismore, Sydney, Jervis Bay, Mt. Kosciusko; Victoria: Melbourne, Beaconsfield,

Gisborne, Castlemaine; Tasmania: Launceston, Ulverstone, Hobart, Bothwell; South Australia: Adelaide, Mt. Lofty, Mt. Gambier; Western Australia: Perth.

10. Genus OPSIRHINA.

Wlk., Cat. Brit. Mus., vi., 1418; Turn., Trans. Roy. Soc. S. Aust., 1904, 240. Type, *O. albigutta* Wlk.

Eyes hairy. Palpi long, porrect, exceeding frontal tuft. Forewings with cell ½ or less; 2 from one-third, 3 from two-thirds, 6 and 7 stalked, 8 sometimes stalked with them, 11 from middle. Hindwings with cell less than ½; 2 from middle, 3 from ⅔, 4 and 5 separate, 7 from one-third or from before one-third, 11 absent, 12 anastomosing shortly with 7 soon after its origin; subcostal cell moderate or rather small, with a basal and sometimes also a median pseudoneurium.

Key to species.

1. Forewings with first and second lines whitish .. .. *albigutta*
   Forewings with first and second lines fuscous, very slender, denticulate .. .. *pyrsocoma*

49. OPSIRHINA ALBIGUTTA.

♂♀. *Opsirhina albigutta* Wlk., Cat. Brit. Mus., vi., 1419.—♀. *Ithathymodes lechriodes* Turn., Ann. Q'ld. Mus., x., 89.

♂. 22-26 mm. Head and thorax brown; face ochreous-whitish. Palpi 2½ to 3; fuscous-brown; upper edge ochreous-whitish. Antennae fuscous-brown; stalk partly whitish. Abdomen brown; tuft large, with some whitish hairs. Legs fuscous-brown; tarsi fuscous with whitish annulations. Forewings triangular, costa straight to middle, then gently arched, apex rounded, termen slightly bowed, scarcely oblique; 8 connate or short-stalked; dark-chestnut-brown, broadly suffused with whitish-grey towards termen and dorsum; a conspicuous white, obliquely transverse, discal mark at two-fifths; two very slender whitish transverse lines; first from ¼ costa to one-third dorsum; second from two-thirds costa to mid-dorsum, sinuate; a series of fuscous subterminal dots nearly parallel to second line, obsolete in middle of disc; cilia brown, apices whitish. Hindwings with termen rounded; subcostal cell with one or two pseudoneuria, 4 and 5 connate or separate; brown; cilia brown. Underside brown without markings.

♀. 58-60 mm. Palpi 6. Forewings broader than in ♂, costa more arched, apex more pointed, termen more oblique; coloration similar, but much paler and grey suffusion more variable; markings similar, but discal mark obsolete or very faintly indicated. Hindwings as in ♂, but paler.

One or two pseudoneuria arise from the subcostal cell, one from base, the second, which is often absent, from about middle.

Queensland: Southport; New South Wales: Mt. Kosciusko; Victoria: Beaconsfield, Gisborne, Inverloch; Tasmania: Launceston, Hobart.

50. OPSIRHINA PYRSOCOMA.

Clathe pyrsocoma Turn., Trans. Roy. Soc. S. Aust., 1902, 185.

Palpi in ♂ 4, in ♀ 5. Forewings with 8 separate, connate, or short-stalked. Hindwings with a single pseudoneurium, sometimes branched, from base of subcostal cell; 4 and 5 separate.

Northern Territory: Darwin; North Queensland: Thursday Island, Cooktown, Herberton, Townsville; Queensland: Gayndah, Brisbane.

11. Genus NEUROCHYTA.

Turn., Trans. Ent. Soc., 1918, 181. Type, *N. edna* Swin.

Palpi moderately long, porrect, reaching beyond frontal tuft, densely hairy. Forewings with 2 from one-third, 3 from two-thirds, 4 and 5 approximated at origin from angle of cell, 6 from upper angle of cell, connate or stalked with 7 and 8, which are stalked, 11 from two-thirds, free, but running close under 12. Hindwings with 2 from middle of cell, 3 from shortly before angle, 4 and 5 stalked from angle, 6 from upper angle, 7 from shortly before angle, 12 anastomosing with cell from near base to one-third; subcostal cell small, two pseudoneuria arising together near base and diverging.

Differs from all other Australian genera in 7 of hindwings arising from near end of cell, and 12 anastomosing with cell near base. Mr. W. H. T. Tams of the British Museum informs me that the eyes are smooth.

51. NEUROCHYTA EDNA.

Clathe edna Swin., Ann. Mag. Nat. Hist. (7), ix., 1902, 166.

♂. 21-22 mm. ♀. 36 mm. Head and thorax whitish-ochreous; in ♀ grey-whitish. Palpi whitish-ochreous; pectinations in ♂ 9, in ♀ 3. Abdomen whitish-ochreous tinged with reddish. Legs whitish-ochreous; anterior pair reddish-tinged. Forewings triangular, costa straight, apex round-pointed, termen scarcely bowed, slightly oblique; ochreous-whitish irrorated with reddish-brown, more densely in ♂; cilia ochreous-whitish, in ♂ tinged with reddish-brown. Hindwings with termen rounded; ochreous-whitish, in ♂ reddish-tinged; cilia concolorous.

Described from four examples, including the type, in the British Museum.

North West Australia: Sherlock River.

12. Genus PERNA.

Wlk., Cat. Brit. Mus., v., 1127. Type, *P. exposita* Lewin.

Eyes hairy; sometimes small. Palpi short, not extending beyond frontal tuft. Forewings with 2 from about one-third, 3 from about two-thirds, 6 and 7 stalked, 11 from middle. Hindwings with cell ⅓ or less; 2 from middle, 7 from before or beyond middle, stalked with 11, which runs into 12; subcostal cell large, with a strong pseudoneurium from its base.

Key to species.

1.	Hindwings white	2.
	Hindwings fuscous or grey	*exposita*
2.	Forewings with discal spot represented by a fuscous bar	*chlorophragma.*
	Forewings with discal spot white	*brevipennis*

52. PERNA CHLOROPHRAGMA.

Bombyx chlorophragma Meyr. (ined?).

♂. 35-37 mm. Head white; sides of face sometimes ochreous. Palpi dark-fuscous; towards apex ochreous. Antennae ochreous-fuscous, stalk white. Thorax and abdomen white. Legs white; tarsi grey. Forewings triangular, costa straight, apex rounded, termen nearly straight, oblique; white; markings grey, clearly defined; a spot on base of costa; a sub-basal spot; a broad line from one-third costa to one-third dorsum, sharply angled posteriorly beneath costa; from this angle a longitudinal bar connects it with a similarly angled line from two-thirds costa to two-thirds dorsum; and this longitudinal bar is sometimes

prolonged to connect with a submarginal line, angled first anteriorly then posteriorly beneath costa, thence wavy to before tornus; cilia white. Hindwings with termen rounded; white; cilia white.

Victoria: Kewell, Birchip; Western Australia: Beverley, Dowerin.

53. PERNA BREVIPENNIS.

Teara brevipennis Wlk., Cat. Brit. Mus., xxxii., 353.—*Bombyx figurata* Luc., Proc. Roy. Soc. Q'ld., 1901, 74.

♂. 34-36 mm. ♀. 46 mm. Head brownish; lower part of face ochreous. Palpi dark-fuscous, towards apex ochreous. Antennae brownish, stalk grey. Thorax fuscous-brown; patagia of ♂ white except in centre. Abdomen whitish; in ♀ grey. Legs whitish-ochreous; in ♀ grey; tarsi fuscous. Forewings oval-triangular, costa arched, apex rounded, termen bowed, oblique; fuscous-brown, in ♀ grey; markings partly darker, partly white; a white basal patch containing a dark spot on costa; a transverse sub-basal dark line, followed by a whitish line, and this again by a dark line from one-third costa to one-third dorsum; similar three lines from two-thirds costa to two-thirds dorsum; median area between lines crossed by a dark-fuscous patch above middle, containing a central white spot, area between patch and dorsum white; in ♀ these markings are less distinct; a broad white subterminal line, not reaching costa, interrupted above middle; a subapical dark costal blotch giving rise to a broad dark submarginal line, posteriorly edged with whitish; a terminal series of white spots; cilia fuscous. Hindwings with termen rounded; white, in ♀ grey; cilia concolorous.

North Queensland: Cairns; Queensland: Brisbane; New South Wales: Newcastle.

54. PERNA EXPOSITA.

Bombyx exposita Lewin, Prodr. Ent., 8, 1805, Pl. vii.—*B. pusilla* Don., Ins. New Holl. Lep., 1805, Pl. xxxv.—♂. *Perna combinata* Wlk., Cat. Brit. Mus., vii., 1757.—♀. *Eriogaster lignosa* Wlk., ibid., vii., 1767.—♂. *E. hebes* Wlk., ibid., xxxii., 571.—♀. *Cosmotriche indistincta* Butl., Trans. Ent. Soc., 1886, 387.—♀. *Poecilocampa brevis* Wlk., ibid., xxxii., 571.—♀. *Tacillia rufo-cinerea* Wlk., ibid., xxxii., 573.

♂. 28-32 mm. Head, palpi, and thorax brown or grey, tips of hairs whitish. Antennae brownish. Abdomen and legs brown or grey. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly bowed, slightly oblique; brown or grey with some whitish irroration, median band rather darker; an irregularly dentate dark-fuscous line from one-third costa to one-third dorsum; a similar line from two-thirds costa to two-thirds dorsum, bent first inwards beneath costa, then strongly outwards, inwards again above dorsum, posteriorly edged with whitish; a white median discal dot; a dentate fuscous subterminal line, edged anteriorly with whitish; cilia concolorous. Hindwings with termen rounded; brownish-fuscous or grey; cilia concolorous.

♀. 34-40 mm. Forewings more elongate, termen more oblique; markings usually as in ♂ but much fainter, sometimes obsolete; coloration brownish-grey.

North Queensland: Cairns, Herberton; Queensland: Clermont, Brisbane, Stradbroke Is., Coolangatta, Toowoomba; New South Wales: Sydney, Jervis Bay; Victoria: Melbourne, Lilydale, Gisborne, Kewell; Tasmania: Hobart; South Australia: Adelaide.

Species unrecognised or wrongly referred to this family.

55. *Nadiasa parvigutta* Wlk., Cat. Brit. Mus., v., 1015 is a ♀ *Pinara*, which I have not identified.
56. *Perna ? flavescens* Wlk., ibid., v., 1128 belongs to the Anthelidae.
57. *Eriogaster ? simplex* Wlk., ibid., vi., 1473.
58. *Poecilocampa leucopyga* Wlk., ibid., vi., 1477 is a synonym of *Ochrogaster contraria* (Notodontidae).
59. *Entometa ignobilis* Wlk., Char. Undesc. Lep., p. 67 belongs to the Psychidae.
60. *Poecilocampa simplex* Swin., Cat. Oxf. Mus., i., 1892, 267 is not Australian. It is probably *Metanastria psidii* Salle from Mexico.
61. *Bombyx fumosa* Luc., Trans. Nat. Hist. Soc. Q'ld., 1894, 104.
62. *Bombyx ocularis* Luc., ibid., 1894, 104 belongs to the Limacodidae.
63. *Bombyx muris-olens* Luc., ibid., 1894, 105 belongs to the Psychidae.
64. *Bombyx effusa* Luc., Proc. Roy. Soc. Q'ld., 1901, 75 is a synonym of *Cynosarga ornata* (Notodontidae).

Index to Genera.

Index to Species.

Synonyms and wrongly referred or unrecognised species in *italics*.

UPPER PERMIAN COLEOPTERA AND A NEW ORDER FROM THE BELMONT BEDS, NEW SOUTH WALES.

By R. J. TILLYARD, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.N.Z. Inst., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plates xlv.-xlvi. and three Text-figures).

[Read 24th September, 1924.]

Up to the present, the earliest known fossil beetle elytra have been those of the Trias. In the Upper Trias of Ipswich, the Order Coleoptera is dominant, nearly half the total number of insect fossils so far discovered there belonging to this Order.

M. D. Zalessky recently described (Mém. Com. Geol., cxxxix., New Series) an alleged fossil beetle (not an elytron) of Permian age, naming it *Microcantharis minutus*, and assigning it to the family Ptiliidae (Trichopterygidae). The total length of this peculiar impression is only 20μ, i.e., about one-twentieth that of the smallest beetles known to exist! Neither in the excellent photomicrographs (x 900) nor in the description of this specimen can I find anything which proves it to be even an insect, much less a beetle, and I do not think further notice need be taken of it.

The assemblage of Upper Permian insect wings discovered at Belmont by Mr. John Mitchell some years back consists of the most highly specialized Palaeozoic types yet discovered anywhere in the world. The Orders so far brought to light there are the Hemiptera-Homoptera, Mecoptera, Paramecoptera and Neuroptera-Planipennia. Such an assemblage is one amongst which there would be a high probability of the occurrence of Coleoptera, since these latter are morphologically more archaic in most respects than any of the Orders just mentioned, except the Homoptera. This being so, both Mr. Mitchell and his more recent co-workers, Mr. and Mrs. T. H. Pincombe, have kept a careful watch for the possible occurrence of beetle elytra during their explorations of the Belmont Beds, and both have been well rewarded. Of a total of thirty specimens discovered (excluding numerous fragments not complete enough to name), no less than six are Coleopterous elytra, and four of them are excellently preserved, so that almost every detail of structure can be made out. Four of these are small elytra which appear to be ancestral to the Upper Triassic genus *Ademosyne* and allies; another (a large elytron with only faint traces of sculpturing, but with a well preserved *alula* exactly like that of the recent genus *Hydrophilus* itself) may be considered, without any reasonable doubt, to be one of the direct ancestors of the existing Hydrophilidae.

In addition to these, it has fallen to Mr. Mitchell himself to make the finest discovery of all, viz., an almost complete elytron, of large size and beautiful preservation, which differs from all known Coleopterous elytra in being exceedingly flat, with a straight sutural margin, and in having a complete system of venation clearly marked upon it. As this fossil exists side by side with true beetle elytra, it cannot itself be one of the ancestors of the Order Coleoptera. Nevertheless it is clear that it belongs to the Order from which the Coleoptera themselves arose, just as the Protodonata belong to the Order ancestral to the true Odonata, though now known to have existed for a considerable period side by side with them. For this fossil, then, the new Order Protocoleoptera is proposed, and its position will be intermediate between the Carboniferous Protoblattoidea (with whose venation it is in rather close agreement) and the true Coleoptera.

Order **COLEOPTERA.**

PERMOPHILIDAE, fam. nov.

Elytra resembling those of recent Hydrophilidae in general form and possessing a well developed *alula* (text-fig. 1, *al*), but without the angulation of the sutural and lateral margins near base, found in recent Hydrophilidae; sutural and lateral margins both very narrow; convexity slight; sculpture slight or absent.

PERMOPHILUS, n.g. (Text-fig. 1).

Medium to large elytra, about one-third as broad as long, with pointed apex; alula well rounded, attached close to base on posterior side, as in Hydrophilidae.

Genotype, *Permophilus pincombei*, n.sp. (Upper Permian of Belmont, N.S.W.).

PERMOPHILUS PINCOMBEI, n.sp. (Text-fig. 1, *a*).

Total length of elytron, 21.5 mm., being the full length except for the extreme tip, which is missing; greatest breadth, 7 mm. Alula almost circular, diameter 1.8 mm. Sutural margin exceedingly narrow, strongly curved for about 4 mm. from base (this portion forms the scutellar margin), then running fairly straight to half-way, finally inclining inwards very slightly. Lateral margin (costa) with basal portion missing for 4 mm., thence running nearly straight and subparallel to sutural margin to half-way, thence curving markedly inwards and finally converging strongly towards sutural margin; although the actual apex is missing, it was evidently strongly pointed, as in *Hydrophilus* (Text-fig. 1, *b*).

No definite longitudinal striae are present, but here and there are to be seen very faint traces of a delicate, branching venation; in several places the area between two more or less parallel veins appears to be furnished with very weakly formed, flattened tubercles of considerable size (diameter 0.2 to 0.3 mm.), either more or less circular or slightly hexagonal. Along the internal edge of the thickened sutural margin near base, running out from the hinge of the alula, is a series of four more strongly marked tubercles of much smaller diameter; probably these are the impressions left by a row of four deeply marked punctae in the original elytron, while the weak, flattened tubercles above mentioned may have been shallow depressions between the obsolescent veins.

Type, Specimen No. 23 T. in Mr. Pincombe's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

This species is dedicated to its discoverer, Mr. T. H. Pincombe of New Lambton, near Newcastle.

PERMOPHILUS (?) MINOR, n.sp.

A poorly preserved but complete elytron; total length, 10 mm., greatest breadth, 3.6 mm. Alula not preserved. Shape somewhat similar to the previous species, but the apex not quite so sharp. No signs of sculpture or venation except, here and there, slight indications of faint longitudinal striae.

Type, Unnumbered specimen in Mr. J. Mitchell's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

PERMOSYNIDAE, fam. nov.

Small elytra without any definite humeral or scutellar angle; more or less strongly convex, about one-third as wide as long, or a little over, with apex moderately pointed. Sculpture consisting of nine longitudinal striae, of which the first * (counting from lateral margin or costa) is continued nearly to apex, receiving two or more of the succeeding striae upon itself distally.

PERMOSYNE, n.g. (Text-fig. 2).

Elytra about 3 mm. in length, with lateral margin not thickened, sutural margin well-formed but narrow, and both margins considerably curved. Striae either plain or punctate, the second, third and fourth striae ending on the first, the eighth ending on the ninth; ninth stria (next to sutural margin) arising basally considerably further from margin than from eighth stria; usually a vestige of a short tenth stria in basal part of interval between ninth stria and margin.

Genotype, *Permosyne belmontensis*, n.sp. (Upper Permian of Belmont).

This genus contains elytra very similar in general appearance to those of the Upper Triassic genus *Ademosyne* Handl., found at Ipswich, Q., and Narellan, N.S.W., but distinguished from them by the very typical arrangement of the striae.

Key to the Species of Permosyne.

1. Elytra with simple longitudinal striae 2
   Elytra punctate-striate 3
2. Longitudinal striae very evenly placed, none of them sinuate except the second, which is only slightly so; lateral and sutural margins distinctly curved when approaching apex .. .. *P. belmontensis*, n.sp.
   Longitudinal striae not so evenly placed, the second, third, eighth and ninth slightly sinuate; lateral and sutural margins nearly straight when approaching apex, so that the elytron is narrower and more triangular distally than in previous species .. .. *P. affinis*, n.sp.
3. Breadth distinctly greater than one-third of length; punctate striae very strongly marked .. .. *P. mitchelli*, n.sp.
   Breadth just one-third of length; punctate striae only weakly marked .. .. *P. pincombeae*, n.sp.

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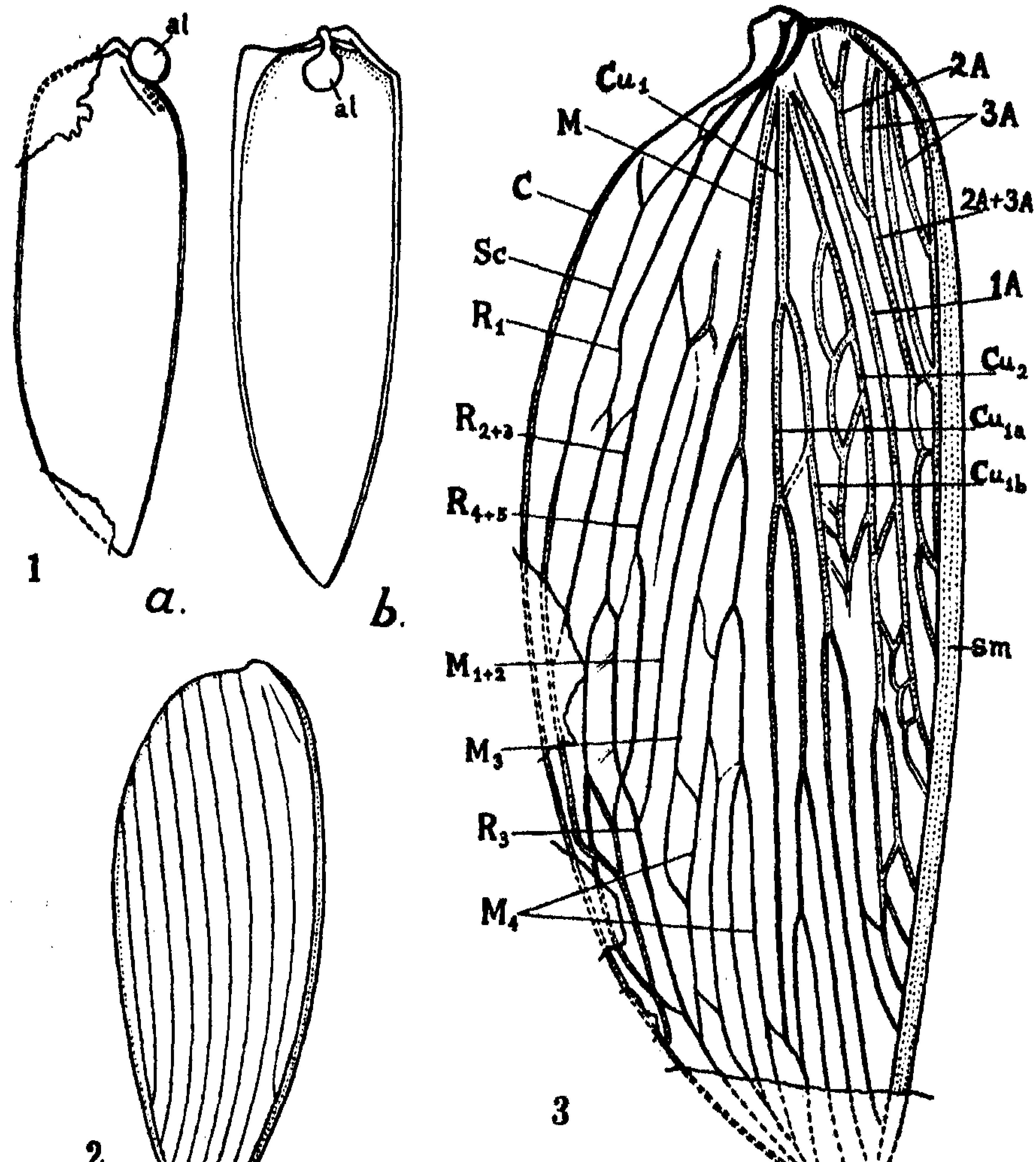
* Most Coleopterists appear to number the striae from the sutural margin outwards; but this is proceeding from the posterior border of the wing towards the anterior border, and appears to me to be illogical; I therefore number them from the anterior border backwards or inwards.



1. *a, Permophilus pincombei,* n.g. et sp., elytron (x 2.7), with missing portions restored by dotted lines; sutural margin to right, lateral margin (costa) to left; *al, alula.* *b, Hydrophilus latipalpus* Cast., Recent, fam. Hydrophilidae, elytron for comparison with *a,* (x 2.7).

2. *Permosyne belmontensis,* n.g. et sp., elytron (x 20); drawn from type-counterpart, sutural margin to right, lateral margin (costa) to left, and slightly broken basal portion restored.

3. *Protocoleus mitchelli,* n.g. et sp., elytron (x 6), sutural margin (*sm*) to right, lateral margin (C) to left, missing apical portion restored by dotted lines. Venational notation (Comstock-Needham):—1A, 2A, 3A, the three anal veins; C, costa; Cu_1, first cubitus, with branches Cu_{1a}, Cu_{1b}; Cu_2, second cubitus; M, media, with branches M_{1-2}, M_3, M_4; R_1, main stem of radius; R_{2-3}, R_{4-5}, the two principal branches of the radial sector; Sc, subcosta.

Permosyne belmontensis, n.sp. (Plate xlv., fig. 1; text-fig. 2.)

Total length of elytron, 3.1 mm.; greatest breadth, 1.3 mm. Sutural margin narrow but strongly marked, well curved. Basal third of lateral (costal) margin apparently with a marked thickening, from the inner edge of which the first three striae appear to arise; second stria ending on first a short distance from its end, third stria ending on first almost at its end; fourth to seventh striae ending on lateral margin not far from apex, eighth almost at apex, ninth on sutural margin at one-fourth from apex. Slight indications of the beginning of a short stria at base of elytron, in the rather wide space between ninth stria and sutural margin.

Type, Specimen 13*a* T., and type-counterpart Specimen 13*b* T., in Mr. T. H. Pincombe's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

Permosyne affinis, n.sp. (Plate xlv., fig. 2).

Total length of elytron, 2.9 mm.; greatest breadth, 1.1 mm. Differs from the previous species in its more pointed shape apically, in the more evenly rounded humeral margin, and in having the lateral margin apparently strongly thickened at its extreme base. Third and fourth striae apparently arising from a common stalk at about one-fifth from base; seventh to ninth striae more sinuate basally; space between ninth stria and sutural margin wider basally than in previous species, with indications of a short tenth stria on it; eighth stria as well as ninth ending on sutural margin.

Type, Specimen No. 92 in Mr. J. Mitchell's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

Permosyne mitchelli, n.sp. (Plate xlv., fig. 3).

Total length of elytron, 3.0 mm.; greatest breadth, 1.2 mm. The elytron is perfect except for the extreme apex and base, which are jaggedly broken off, and the sutural margin, of which only the middle third is preserved. Punctae strongly marked throughout, the distances between successive punctae being definitely less than the distances between successive striae in the middle of the elytron. Second stria very sinuate basally, arising close to third; the other striae very regularly arranged, not sinuate.

Type, Specimen No. 79 in Mr. J. Mitchell's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

This species is dedicated to its discoverer, Mr. John Mitchell.

Permosyne pincombeae, n.sp. (Plate xlv., fig. 4).

Total length of elytron, 3.3 mm.; greatest breadth, 1.1 mm. Differs from the previous species in being longer and narrower, much more pointed apically, and having the punctate striae more weakly marked, the distances between successive punctae being about the same as those between successive striae in the middle of the elytron. The elytron is completely preserved, but, unlike the previous three species, it is strongly carbonized, and the impression is not as clear as in the others.

Type, Specimen No. 14 T. in Mr. Pincombe's Collection.

Horizon: Upper Permian of Belmont, N.S.W.

This specimen is dedicated to Mrs. T. H. Pincombe, who has done valuable work with her husband in exploring the Belmont Beds.

PROTOCOLEOPTERA, ordo nova.

Primitive insects resembling Coleoptera but having flattened, tegminous elytra with straight sutural margin and a complete system of wing-veins developed. Costal margin greatly curved. Membrane strongly punctate between the veins.

PROTOCOLEIDAE, fam. nov. (Plate xlvi.).

Large, broad elytra having all the veins from Rs to Cu_2 strongly branched, one branch of the radius curving round subparallel to costa and junctioning with the successive branches of Rs and M in turn. Cu_2 a long vein marking off a definite anal area, ending more than half-way from base; on this area, 1A lies just below Cu_2 while 2A and 3A arise in a group by themselves from the curved basal portion of the sutural margin.

PROTOCOLEUS, n.g. (Plate xlvi., fig. 5; text-fig. 3).

Elytron broad, flat and fairly strongly chitinized, with strongly curved costal margin. Sc arising as a deep furrow vein, close to costal margin at base, then diverging slightly from it, but approaching it again distally. R_1 a strong, slightly curved vein ending distally on R_2; Rs arising close to base and branching at about one-fifth of the wing-length from base; R_{2-3} branches again at about half-way along the wing, R_2 running into R_1 but R_3 continuing to run sub-parallel with the margin and receiving the ends of R_{4-5} and the branches of M upon itself, finally ending up close to the apex. M developed basally as a weakly chitinized and rather broad, flat vein, with its first anterior branch at about one-fourth of wing-length; from this point onwards it becomes a strongly marked but narrow vein, with its main stem approximately along the mid-longitudinal axis of the elytron, though slightly arching between successive branches; four anterior branches are given off in succession, the first three of which end up on R_1 (extreme apex missing). Cu a broad, flattish, rather weakly chitinized vein, branching into Cu_1 and Cu_2 very close to base; each of these veins is again branched more or less dichotomically, the upper part of Cu_1 running below and subparallel to the main stem of M. 1A arises as a broad, flat vein just below Cu_2, and runs with a slight curve below it to end, without branching, at about two-thirds of the wing-length. The other two anal veins arise far from 1A on the curved basal portion of the sutural margin, 2A being simple, 3A branched; the anterior branch of 3A junctions with 2A to form a Y-vein. Sutural margin broad and nearly straight except at base, where it is stouter, narrower and much curved.

Genotype, *Protocoleus mitchelli*, n.sp. (Upper Permian of Belmont, N.S.W.).

PROTOCOLEUS MITCHELLI, n.sp. (Plate xlvi., fig. 5; text-fig. 3).

Total length of preserved portion of elytron, 21.5 mm., indicating a complete elytron of total length about 24 mm.; greatest breadth, 7 mm. The elytron is ochreous in colour on the usual pale-greyish, cherty shale of the Belmont Beds, and is impressed with the underside uppermost, so that the veins are all grooves of varying depths, with the exception of the deeply concave base of Sc, which stands up as a strong ridge; the strongly formed base of R appears as a deeply impressed groove below the raised Sc. Apart from these inequalities, the rest of the elytron is very flat. The extreme base of the elytron is of peculiar form, the attachment to the thorax having been apparently effected by means of a single large callus at the base of the subcosta and radius; this

swelling perhaps represents a fusion of originally separate anterior and posterior calli. From below this callus the posterior margin arches strongly away in a direction almost exactly opposite to that of the costa, and then curves strongly round into the sutural margin; hence the extreme basal posterior part of the tegmen lies actually at a level anterior to the origins of the veins Sc, R, M and Cu. This is in strong contrast with the condition seen in Blattoidea, where the base of the costal margin projects more or less anteriorly to the rest.

Venation as given in the generic definition. Sculpture consisting of very numerous, minute pits or punctae, scattered for the most part irregularly over the whole of the membrane between the veins, but showing a marked tendency to become arranged in lines along each side of the veins. The spaces between successive veins contain these pits from two to four deep, according to their width.

By turning the photograph in Plate xlvi., fig. 5, upside down, so as to reverse the lighting, the elytron will appear with raised veins and sunken pits; this is the appearance which it would have had in life if viewed from above. In the actual impression, the pits show as tiny raised tubercles, the veins as grooves or channels.

Type, Specimen No. 81 in Mr. J. Mitchell's Collection (date on label, 1922).

Horizon: Upper Permian of Belmont, N.S.W.

This species is dedicated to its discoverer, Mr. John Mitchell, to whom also the first discovery of true Coleoptera in these beds is due.

In conclusion, I desire to express my thanks to Mr. W. C. Davies, Curator of the Cawthron Institute, for the excellent photographs from which the Plates have been made.

Explanation of Plates xlv.-xlvi.

Plate xlv.

Fig. 1. *Permosyne belmontensis* n.g. et sp. (x 18.5).
Fig. 2. *Permosyne affinis* n.g. et sp. (x 21).
Fig. 3. *Permosyne mitchelli* n.g. et sp. (x 21.5).
Fig. 4. *Permosyne pincombeae* n.g. et sp. (x 17).

Plate xlvi.

Fig. 5. *Protocoleus mitchelli* n.g. et sp. (x 8).

THE INFLUENCE OF CERTAIN COLLOIDS UPON FERMENTATION.

Part i.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

(Six Text-figures.)

[Read 29th October, 1924.]

While testing the fermentative activities of the high temperature organism, an experiment was made with powdered charcoal suspended in a fluid containing ammonium sulphate, potassium citrate, sodium phosphate and magnesium sulphate. A quantity of carbon dioxide was given off and it was thought that the charcoal had been fermented. Soot prepared by allowing the smoky flame of a bunsen burner to play against a vessel containing water also seemed to be fermented. The same applied to soot purified by ignition followed by treatment with alcohol and ether.

Following up the matter, it was discovered that it was neither the soot nor the charcoal, but the citrate of potash in the medium that had been attacked. In the absence of carbon, the citrate was not fermented, a fact which was ultimately traced to the conditions that obtained in the experiments. The bacteria had been chilled and in this state were powerless either to increase in numbers or to utilise citrate.

Not only did charcoal and soot overcome this inertness of the microbes, but kieselguhr and fuller's earth had the same effect. These substances are colloids and it would appear that this group of bodies is capable of overcoming certain conditions inimicable to fermentation.

The action of colloidal bodies is of considerable importance and little has been done with regard to their influence upon fermentation.

As this organism seemed to be very well adapted for the elucidation of questions of this nature, chiefly on account of the fact that it grows at 60° and the fluids are automatically purified, it was decided to investigate the action of some of the ordinary mineral and other colloids.

Among the latest works upon the action of colloids in hastening bacterial fermentation is that of Söhngen (Centr. f. Bakt. 2te Abt., 38, 1913, 621). The paper bears upon the kind of phenomena that are likely to be met with in work upon the fermentative activity of the high temperature organism, and some of the points may be noted. He found that bacteria such as *B. fluorescens liquefaciens* and *B. phosphorescens* agglomerated around the colloid particles. In the case of *Azotobacter*, he found that certain colloids, such as filter paper, increased the fixation of nitrogen, fivefold. Incidentally it was shown that suspensions of

colloidal silica and hydrated ferric oxide absorbed twice as much oxygen from the air as plain water. Fluids containing these colloids will therefore be more oxygenated than colloid-free liquids.

B. ochraceus has the power of dissolving starch and this is increased in the presence of electro-negative humus and colloidal silica and decreased by electro-positive colloidal ferric and aluminium oxides. The colloids scarcely increased the numbers of bacteria but considerably enhanced or diminished the enzymic action.

The fermentation of urea by *M. ureae* was increased by about 30% in the presence of electro-negative colloids and especially by animal charcoal.

The alcoholic fermentation was peculiar. Alkaline humates depressed the fermentation, while colloidal ferric oxide, aluminium oxide, silica and humic acid were indifferent. The bio-colloids, such as peat, filter-paper, blood charcoal and garden soil, accelerated the fermentation by about 50% and this seemed to be due to the facility afforded to the escape of the carbon dioxide from the fibres and angles of the colloids.

The general impression gathered from the paper is that the colloids play a mechanical and a bio-chemical part. The mechanical was shown in the influence of cotton and paper projecting from the fermenting liquids in the case of strong aerobes such as *Azotobacter* and *B. phosphorescens* and of the bio-colloids in the alcoholic fermentation. The bio-chemical part was demonstrated by the increased enzymic action in the case of *B. ochraceus.*

The nutritive solution employed in most of the subsequent tests consisted of a mixture of salts* adjusted to give a good buffer effect in order that a minute droplet of fluid could be abstracted for the determination of the active acidity that is the pH value.

Thirty c.c. of the ammonium phosphate fluid were generally put into a 100 c.c. distillation flask, together with 0.1 gram of lactose, a sugar which fermented more slowly than the other commonly occurring carbohydrates (These Proceedings, 1923, 478). Before the addition of the lactose the fluid was brought to pH 6.8 or 7.0 with drops of dilute ammonia and the colloid was afterwards added. The flasks were inserted into the fermentation apparatus and when their temperature rose to 60°, the fluids were seeded with two or three drops of a warm suspension of bacterial cells made by taking half of a 20 hours agar slope and distributing it in 5 c.c. of warm water with the aid of a pipette having a capillary nozzle. In each set of tests, the same number of drops of suspension was added to each flask.

The first tests that are being recorded were made with kieselguhr, silica and kaolin. Along with them are tabulated the results obtained from the fermentation of lactose with powdered willow-charcoal and with hydrocellulose prepared by the action of alkaline permanganate upon cotton wool.

The numbers in the tables that follow represent the milligrams of carbon dioxide caught by the baryta solution through which the air coming from the fermentation flask had to pass. The fermentation apparatus has been described in a former paper (These Proceedings, 1921, 84).

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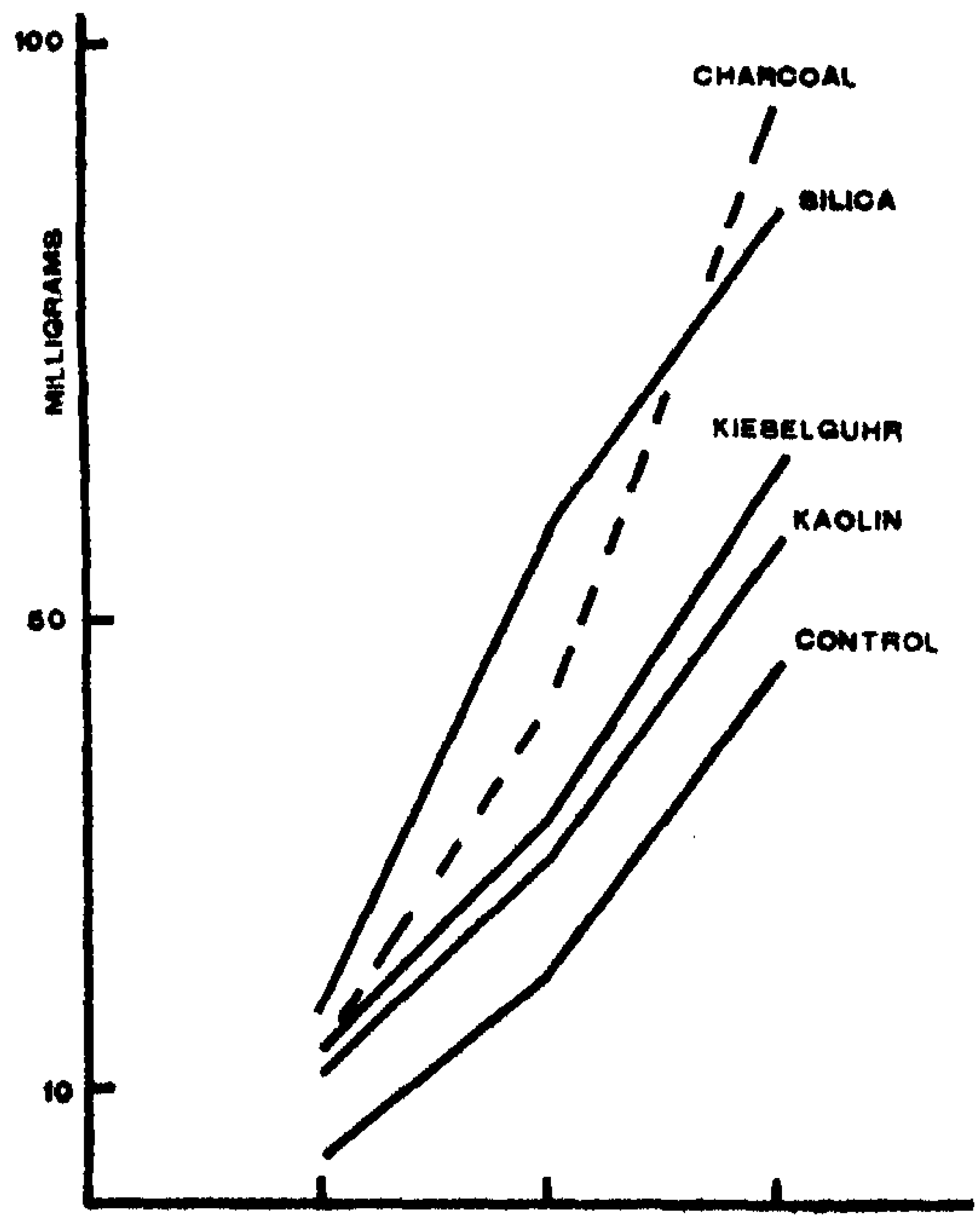
* Ammonium phosphate 3, potassium dihydrogen phosphate 1, magnesium sulphate anhyd. 0.5, sodium chloride 0.25, calcium chloride 0.25 grams, bromthymol blue 20 c.c. and water to 1000 c.c.

Table i.—The Influence of various Colloids upon Fermentation.
Carbon dioxide in mg.; aggregate amounts..

	Days.	1	2	3	4
	30 c.c. of nutritive fluid containing				
Set 1	lactose and kieselguhr 0.1 gm.	13	33	64	.
	" " " 1.0 gm.	10	49	88	.
	" and silica 0.1 gm.	16	58	85	
	" " " 1.0 gm.	21	79	90	.
	" and kaolin 0.1 gm.	11	29	57	.
	" " " 1.0 gm.	17	51	91	.
	" only (control)	4	19	46	70
Set 2	lactose and charcoal 0.2 gm.	13	42	94	99
	lactose only	—	17	42	69
	charcoal only	1	.	.	2
	lactose and hydrocellulose 0.2 gm. ..	2	22	54	76
	hydrocellulose only	1	.	.	2

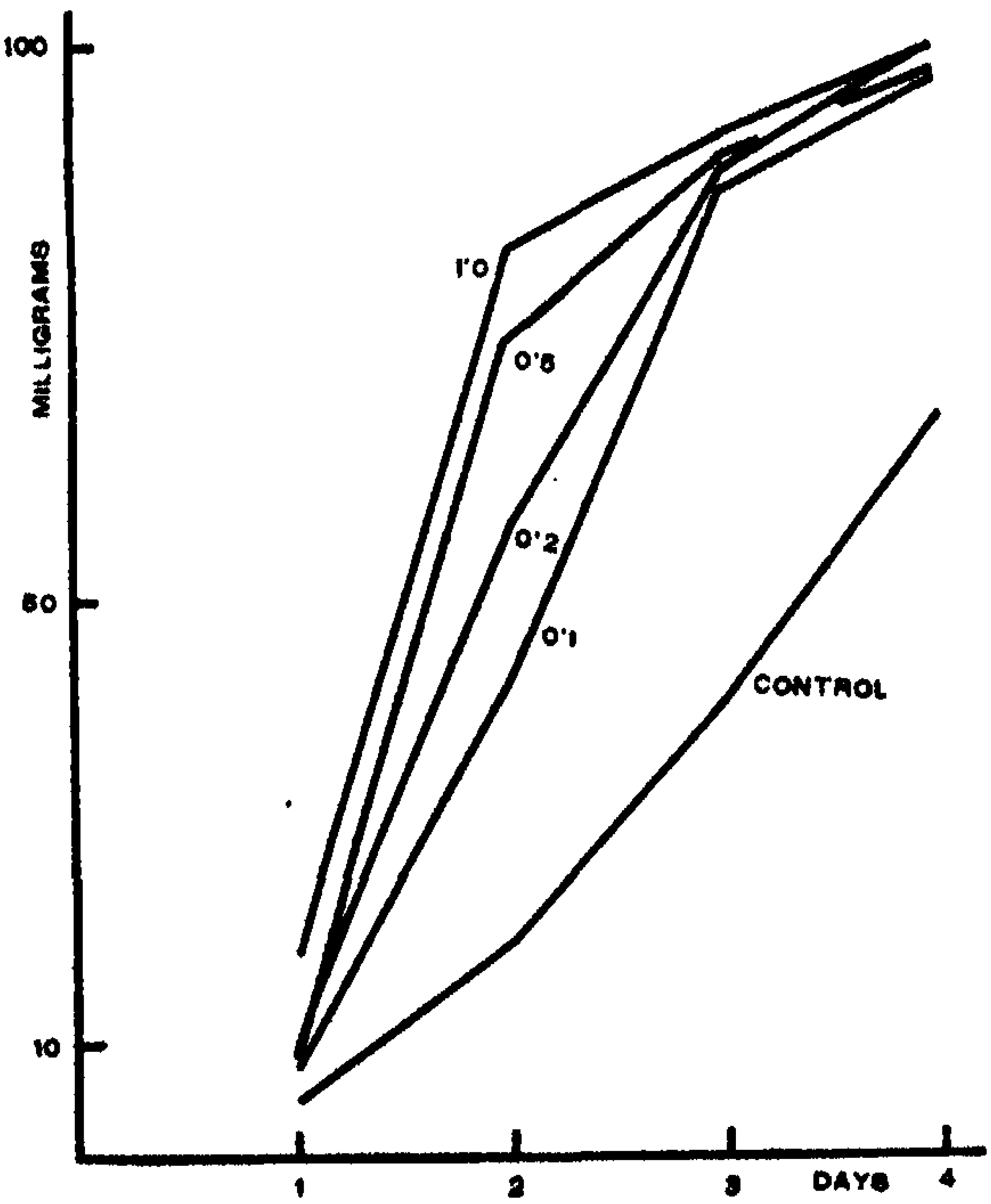


The most active of the colloids was silica. The sample came from the stock bottle bearing the label "Silica, pure precipitated": it had been bought many years ago and probably had not been purposely "activated." All the colloids accelerated the fermentation, the larger quantities more than the smaller but the increases were not proportional to colloid present.

Fuller's earth had in the preliminary experiments acted as an accelerating colloid and a test was made with increasing quantities of it.

Table ii.—Fuller's Earth; carbon dioxide in mg.; aggregate amounts.

Days	1	2	3	4
30 c.c. of nutritive fluid with 0.1 grm. lactose and				
nothing (control)	5	19	41	67
fuller's earth 0.1 grm.	6	48	87	97
" " 0.2 grm.	11	57	89	100
" " 0.5 grm.	9	74	90	98
" " 1.0 grm.	18	82	93	100



The lactose which was used in all these tests was the ordinary commercial powder and 0.1 gram was capable of yielding from 100 to 105 mg. of carbon dioxide. For this reason the curves of the numbers from 80 to 100 generally become depressed as they near the limit.

The experiment with the fuller's earth showed a considerable increase in the speed of the fermentation with the smallest quantity and the speed increased with the colloid. The amounts obtained on the second day gave an idea of the relative activity.

A preliminary test with 0.5 gram of asbestos fibre had shown that it was an accelerating agent. Further tests corroborated the fact. When varying quantities were added to the flasks it was found that the first decigram of colloid had the most influence; with more the acceleration was relatively slower. Many tests were made and the results have been grouped together and the averages taken.*

Table III.—The Influence of Asbestos. Carbon dioxide in mg.

Days	1	2	3	Number of tests.
30 c.c. of nutritive fluid containing 0.1 gram of lactose and				
Asbestos, 0.5 gram	27	88	99	4
" 0.2	25	78	92	2
" 0.1	18	76	90	2
" 0.01	8	34	62	1
control (no colloid)	8	34	58	5
French chalk, 0.2 gram	12	44	59	2

* The probable error of the mean was calculated in each case and when taken to the nearest whole number, it varied from two to three.

The accelerating influence is clearly seen and a perusal of the graph indicates the efficiency of quantities of asbestos greater than 0.1 gram per portion.

Two tests with French chalk are included. These show that the substance accelerated the fermentation at the beginning but fell away by the third day.

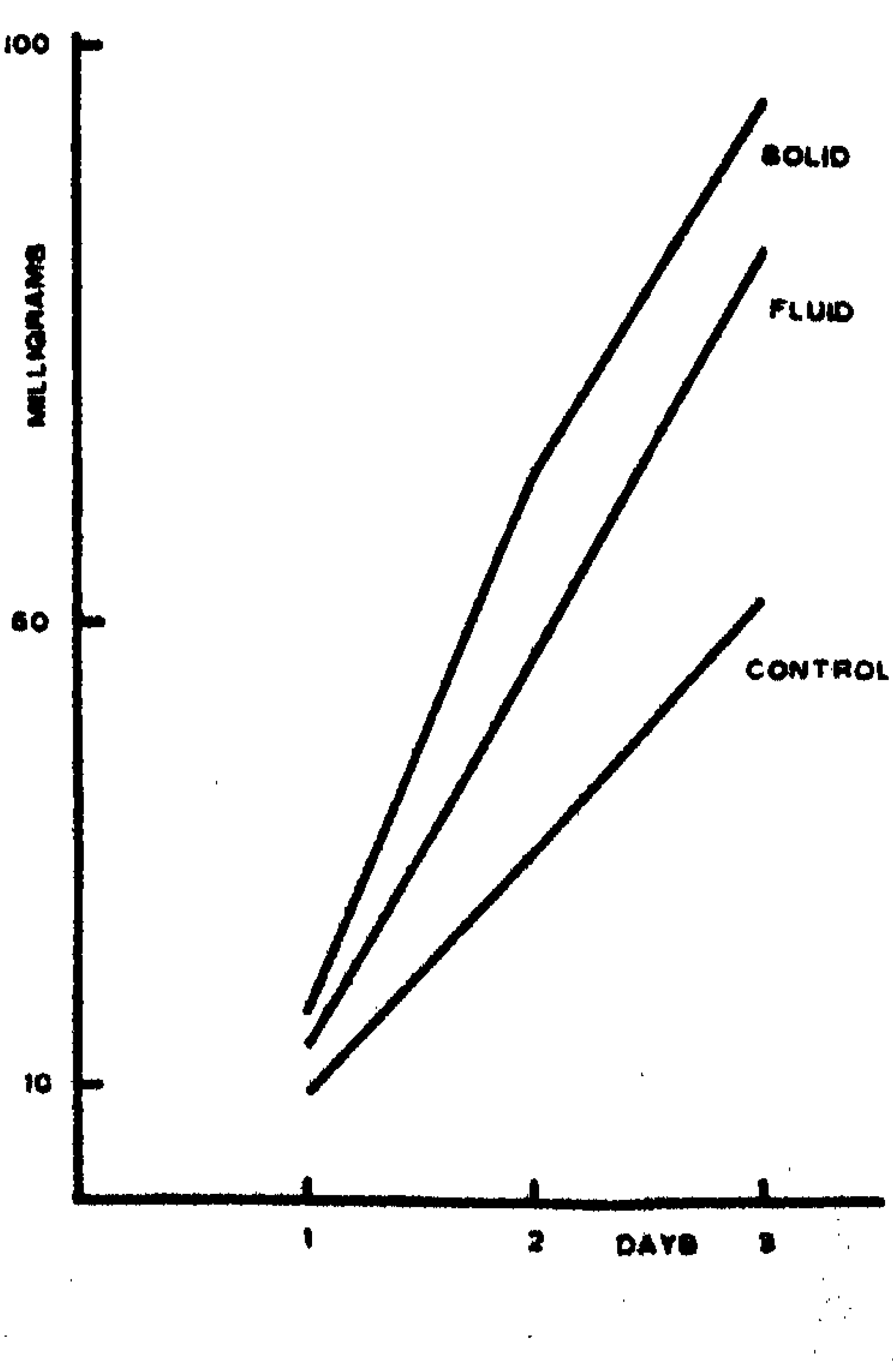
The influence of agar was tested on several occasions. It was used both in the powdered form and the ordinary commercial fibre.

In some cases the agar, at the temperature of fermentation, slowly softened and it was noted that in these the short lengths of the fibre had, at the end of the experiment, a rectangular section with rounded corners in strong contrast to the H-shaped section of the raw wetted fibre. In other cases the section was like a podgy H, as if the centre of the H had swollen and the ends of the uprights had dissolved.

Agar was tested by itself but there was no fermentation. It was also completely dissolved in the autoclave and maintained in the fluid condition. On the whole the agar in the solid state was more effective than that in the liquid state. One test with varying quantities of the fibre showed that 0.1 gram was as active as a larger quantity.

Table iv.—The Influence of Agar. Carbon dioxide in mg. Mean results.

Days	1	2	3	Number of tests.
30 c.c. of nutritive fluid with 0.1 gram. of lactose and				
0.1 to 0.3 gram, agar in powder or fibre form	16	63	95	8
0.2 gram. of fibre dissolved	13	47	82	4
no agar	9	30	52	9



It is obvious that agar acts as a stimulant, accelerating the activity of the organism. The relative effects are clearly brought out in the graph where it is seen that the solid colloid is more effective than the liquid.

Working with a very dilute saline solution (0.06%), Söhngen noted that the cells of *B. fluorescens liquefaciens* agglomerated around the particles of colloid. He considered that this occurred because the potassium, sodium and ammonium ions were condensed on the surfaces of the colloid particles and that therefore more nutriment was offered there than at places in the body of the fluid. In the experiments with agar which have been described an agglomeration of bacteria on the solid particles did not occur; they were distributed uniformly throughout the fluid. With the other colloids, particles of precipitated calcium phosphate were seen adhering to the fragments, but an excess of bacterial rods was not seen on or near the surfaces of the fragments. It should be remembered that the fluids were comparatively rich in saline matter (0.6%) and there would not be the same inducement for the bacteria to seek the colloid particles as in Söhngen's experiments.

The colloids that had so far been tested were electro-negative. The particles of most colloids carry a negative charge* but a few, such as the hydroxides of iron and alumina, carry a positive charge. It was considered advisable to test these hydroxides to see how far the charge carried by the particles might be responsible for the acceleration produced by the presence of the colloids in the fermenting fluids.

Aluminium hydrate chanced to be in stock and was tested. It depressed the fermentation. Then ferric hydrate was prepared and its addition to the nutritive fluid accelerated the fermentation. Thus these two electro-positive colloids were at variance. While the work was in progress, the stock of ferric hydroxide ran out and a fresh lot was prepared. This gave a faster fermentation than the older lot and suggested that the hydroxides might be more effective when freshly prepared than when they had been kept for some time.

A new lot of aluminium hydrate was prepared and compared with the stock.

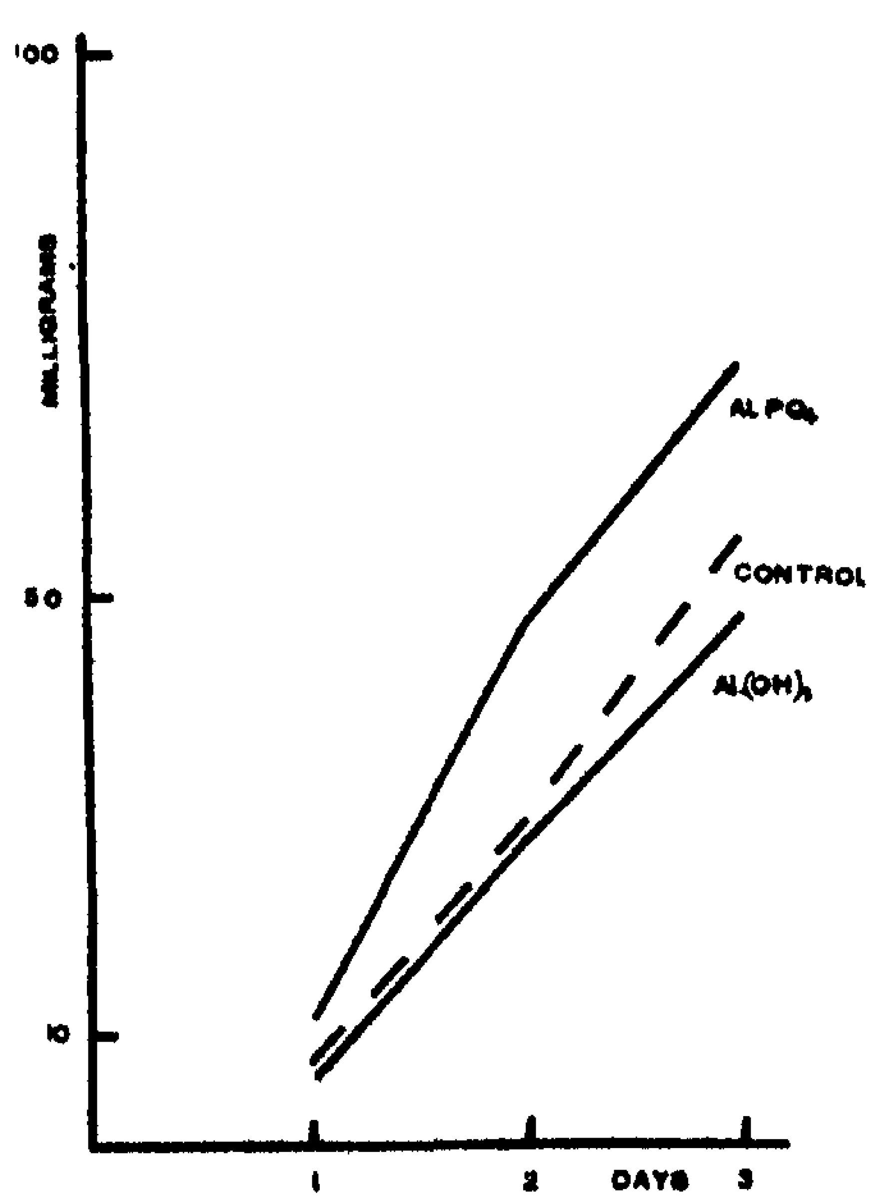
It seemed possible that in the presence of the phosphates of ammonia and potash of the nutritive fluid, the hydroxides might be converted to phosphates and the subsequent action would be that of the phosphate rather than the hydroxide. Accordingly suspensions of the phosphates of iron and alumina were prepared and tested when recently made and when about a month old.

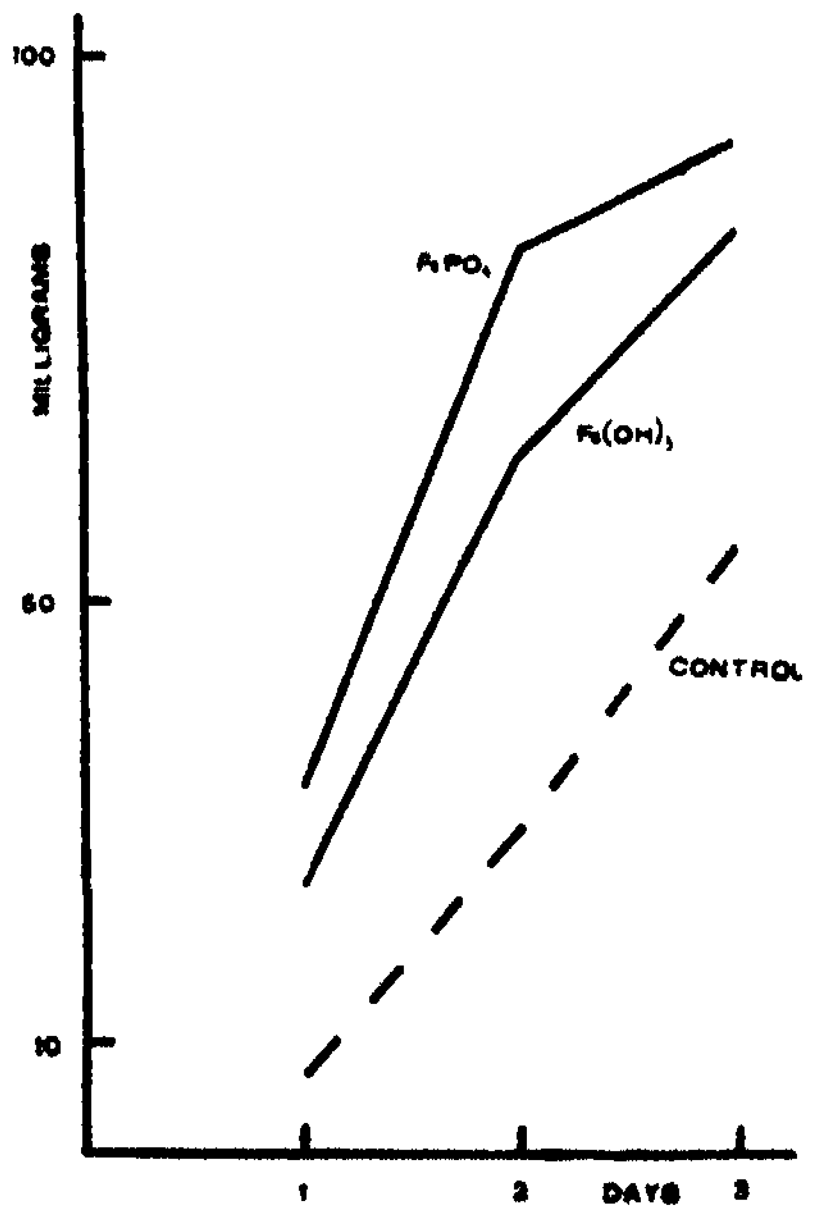
In the table it is shown that aluminium hydroxide caused a retardation in the evolution of the carbon dioxide as compared with control fluids. It acted

* Colloid particles such as most powders, silica, charcoal, kaolin, starch, quartz, felspar, cotton, paper, clay, and asbestos are electro-negative when suspended in water. The hydroxides of iron and aluminium are electro-positive. (See Bayliss, Principles of Physiology, 1921, 92, and Burton, Fourth Report on Colloidal Chemistry, Brit. Assoc. Adv. Sci.). Young actively growing bacteria and vegetable cells in general are positively electrified and move to the negative pole, i.e. they are electro-negative, when suspended in neutral solutions. Protozoa and animal cells in general carry a negative charge and move towards the positive pole. But old or poorly growing bacteria are electro-positive. Dale found that the protozoa of the frog were negatively charged when in slightly alkaline fluids as in the frog's blood but, when in acid fluids, the charge was reversed. (Thornton, Proc. Roy. Soc., 82B, 1910, 638.)

Table v.—The Influence of the Hydroxides and Phosphates of Iron and Aluminium. Carbon dioxide in mg.; aggregate amounts.

Days	1	2	3	
80 c.c. of nutritive saline fluid with 0.1 gram of lactose and 100 mg. of				Number of tests.
Aluminium hydroxide	6	28	48	13
Alumina	6	25	55	4
Ferric hydroxide	24	63	84	6
Aluminium phosphate	11	47	71	4
Ferric phosphate*	38	82	92	4
Control (no colloid)	7	29	55	13
Aluminium hydroxide (old)	4	20	44	6
Ferric hydroxide (old)	11	35	69	8
Aluminium phosphate (old)	11	41	70	7
Ferric phosphate (old)	10	30	53	4





as a depressant.† The old hydroxide which had been prepared for some years and had been stored as alumina cream was more active in this negative way than the freshly prepared material. Ignited alumina was practically indifferent.

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* Four weeks later the ferric phosphate was sterilised previous to being used in some experiments with yeast. It curdled during the heating but this did not affect its efficiency, for two tests with lactose had an average of 38—77—86 and four controls had an average of 9—29—49 for 1, 2 and 3 days. The phosphate had originally been prepared by adding an excess of sodium phosphate to a solution of acidified ferric chloride, neutralising with dilute ammonia and washing by suspension and filtration. There was a considerable loss as the phosphate began to "milk" and much passed through the filter.

† The use of artificial colloidal precipitates (e.g. alumina cream) as a surface on which B. aceti can develop is not advantageous,—Fowler and Subramaniam (through Chem. and Ind., 42, 1923, 1146).

Since the actions of aluminium hydroxide and ferric hydroxide are at variance, the one depressing and the other accelerating the fermentation of lactose, it is clear that the nature of the electric charge on the colloidal particles has no influence upon their activities during fermentation.

The phosphates of these metals acted as accelerating colloids. The old and freshly prepared phosphates of alumina were quite active. The old phosphate of iron was indifferent but the recently prepared specimen was very active indeed. It was the most active colloid that had been examined.

The acids formed during the fermentation may have dissolved some of the metallic hydrates but it would appear that even if this did occur, the metallic salt had no influence upon the course of the fermentation. In some cases the acidity rose from pH 7.0 to pH 6.4, but when some of the tests were neutralised, the curves did not differ in character from those which were not neutralised.

It is probable that the metallic hydroxides were not converted to phosphate, at least to any considerable extent, for the fluids made neutral (pH, 7.0) at the start before the addition of the hydroxide, never became alkaline. Nor was the quantity of ammonia caught in the baryta water in excess of that found in the control flasks. Although there was enough aluminium hydroxide added to absorb all the phosphate as aluminium phosphate, the evidence did not justify the assumption that the reaction had occurred.*

The main object of the experiment was to see if the electric charge on the colloidal particle influenced its activity, and the answer to the question seems to be in the negative.

Kaserer found that the silicates and phosphates of iron and alumina favoured the growth of *Azotobacter*. These tests confirm this so far as the phosphates are concerned, for they certainly have a distinctly favourable influence upon fermentation (and upon growth, for the fluids which showed a slow fermentation were not so turbid as those which showed a rapid fermentation). Alumina has a slightly depressing action and it is shown elsewhere that silicate of aluminium (kaolin) accelerates the fermentation. It is therefore probable that gelatinous aluminium silicate is also an accelerating agent.

Remy and Rösing found that colloidal ferric hydroxide increased the growth of *Azotobacter* and *Granulobacter* and this is in keeping with these experiments. Söhngen, on the other hand, found that the enzymic activity of *B. ochraceus* was checked by colloidal ferric hydroxide as well as by aluminium hydroxide.

So far in this research the colloids were used in the insoluble condition, while the other investigators used the silicic acid and the ferric and aluminium hydrates in the dissolved or sol condition. Sometimes the sol became converted to the gel by the other constituents of the medium or solution as in Söhngen's experiment (pp. 625-6) with *B. fluorescens liquefaciens*. He notes that colloidal ferric hydrate and silicic acid were flocculated upon their addition to the culture fluid which contained 0.06% of saline matter including 0.02% of sodium-

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* Judging from the experiments of Lichtenwalner, Flenner and Gordon upon the adsorption of phosphate by alumina gels (Soil Science, xv., 1923, 157), it would seem that the 0.1 gram of aluminium hydrate in these experiments would adsorb approximately 7 mg. of PO_4 in three days from the culture fluid containing 0.006 N phosphate. This represents an adsorption of 8 % of the phosphate added.

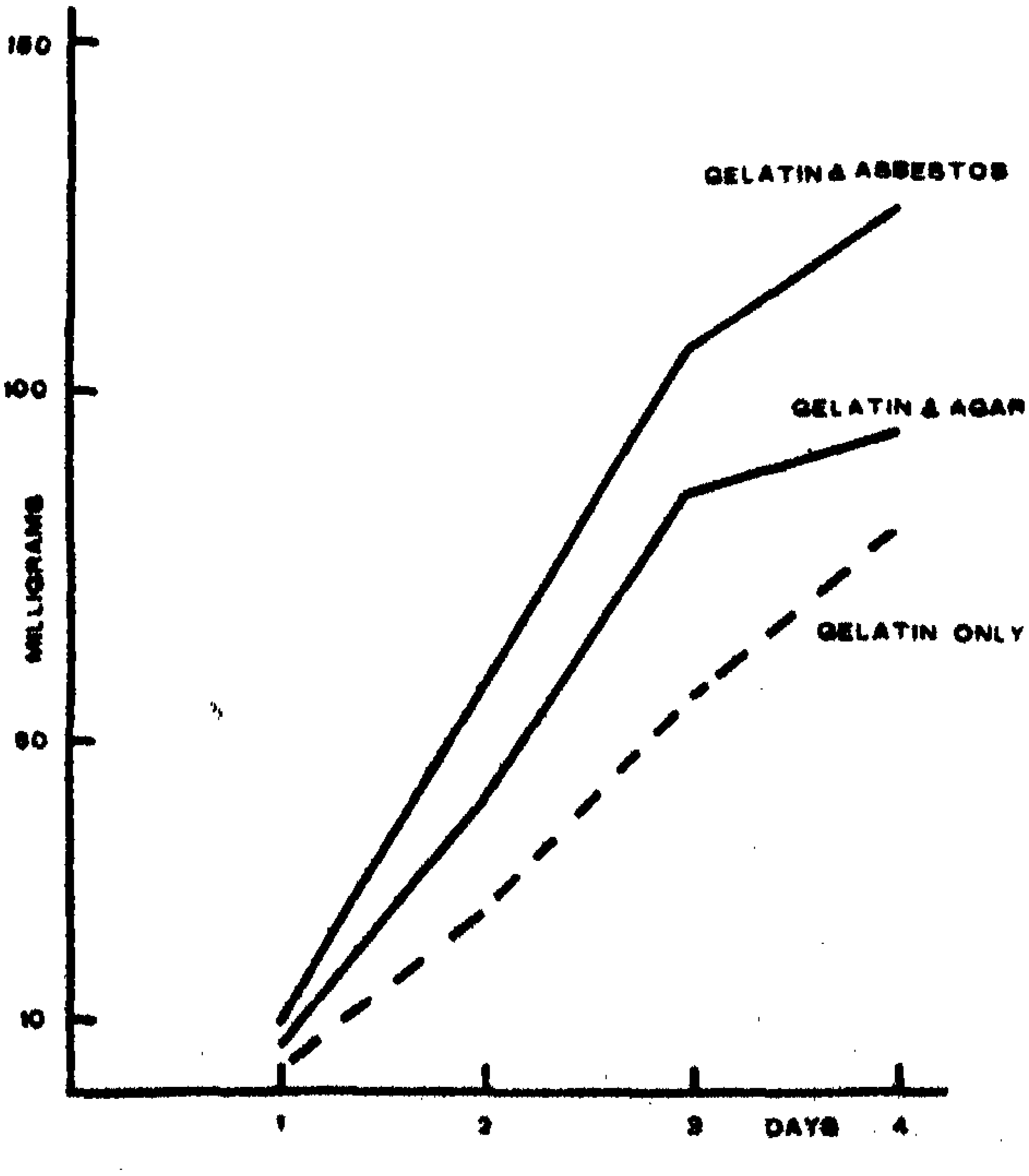
potassium tartrate. With the larger proportion of buffer salts used in the experiments in this paper, it was expected that a soluble colloid would become precipitated and accordingly only the precipitated colloids were employed. It was subsequently found that colloidal ferric hydrate was coagulated, but that colloidal silicic acid was not.

Gelatin is a colloid and, as we have seen, it is fermented by the bacterium. Judging by the effect of liquefied as against non-liquefied agar, the solubility of the gelatin in the fermenting fluid at 60° should diminish any accelerating action it might have, but it should not bring it down to the vanishing point. Acting as a colloid, and all the colloids, with the exception of aluminium hydrate and French chalk, that have been tested in this research have been accelerating agents, it should accelerate its own fermentation, especially in the beginning, before it has had time to become destroyed.

How far this occurs was the object of a few tests. In these 0.2 gram of gelatin was added to 30 c.c. portions of ammonium phosphate nutritive fluid together with 0.1 gram of lactose or of agar or of asbestos fibre. The idea of adding these colloids was to see the effect of superimposing substances with a known accelerating action upon the unknown gelatin.

Table vi.—The Action of Gelatin. Carbon dioxide in mg.; aggregate amounts.

Days	1	2	3	4	Number of tests.
30 c.c. of nutritive fluid containing					
1. Gelatin only	3	25	56	80	6
2. Lactose only	9	34	62	91	4
3. Gelatin and lactose	16	68	119	161	4
4. Gelatin and agar	6	41	72	94	4
5. Gelatin and asbestos	9	57	106	126	3
1 + 2 above	12	59	118	171	



As before, the average of the tests are alone recorded.

The addition of the results of Nos. 1 and 2 is so near the result of the combined lactose and gelatin (No. 3) that it may safely be said that, under the conditions, gelatin did not accelerate the fermentation. When the known accelerating colloids, agar and especially asbestos (Nos. 4 and 5), were added to the gelatin, the fermentation was considerably increased. Their behaviour seems to confirm the finding that gelatin does not function as an accelerating colloid.

The nutrient medium used throughout these experiments contained a small quantity of calcium chloride (0.025%) and, as it had been noted in some subsidiary tests that the absence of this small quantity seemed to give a speedier fermentation, the matter was definitely tested in the following. A nutrient medium was prepared containing $(NH_4)_2HPO_4$ 0.4%, KH_2PO_4 0.15%, and $MgSO_4$ 0.05%. One half of a set of flasks received this medium while another half received the same plus 0.025% of calcium chloride. All received 0.2 gram of lactose. On neutralising the fluids, which had previously been coloured with brom-thymol blue, a precipitate of calcium phosphate was thrown down in those flasks containing the calcium salt but there seemed to be enough calcium left in solution to influence the results.

Table vii.—The Influence of Calcium in the Medium. Carbon dioxide in mg.; aggregate amounts.

Days	1	2	3	4
30 c.c. of nutrient fluid with lactose and				
Asbestos, 0.1 gm.	12	39	80	99
Fuller's earth, 0.1 gm.	16	48	89	109
Activated silica, 0.1 gm.	14	60	92	108
No colloid	12	34	55	79
	10	32	53	75
Calcium chloride and Asbestos 0.1gm.	14	42	68	88
,, ,, ,, fuller's earth, 0.1 gm.	11	32	71	103
,, ,, ,, activated silica, 0.1 gm.	12	41	93	106
,, ,, ,, no colloid	9	23	43	64
	10	24	46	66

As in the previous experiments, the colloids accelerated the fermentation of the lactose in the presence of calcium chloride and they also accelerated the fermentation in its absence. It is evident from the results that calcium chloride unfavourably influences the speed of fermentation.*

One point that may be mentioned is that at the end of the third day the fluids in the flasks were quite acid. They were neutralised, but this did not seem to have any effect. To make quite sure, a test was made with the medium containing the calcium chloride and a small quantity of silica was added to each flask. Two flasks were not neutralised after the start while two were neutralised at the end of the second day and one of these again at the end of the third day. The pH values at the end of each day are recorded.

It is clear that the neutralisation of the fermenting fluids made no difference in the production of the carbon dioxide. This is in contrast with the fermentation of dextrose and saccharose, the acids developed from which had a marked influence in retarding the fermentation (These Proceedings, 1923, 476).

* Calcium acetate exerts an inhibitory action on acetification by *B. aceti*. which is ascribed to the calcium ion. Fowler and Subramaniam (through Chem. and Ind., 42, 1923, 1146).

Table viii.—The Influence of Neutralisation on the Fermentation of Lactose.

Days 30 c.c. of nutritive fluid with 0.2 gram lactose and	1	2	3	4	1	2	3	4
					pH value.			
Silica, 0.1 gram; not neutralised	13	60	87	100	6.8	6.4	6.2	6.2
" " " "	14	64	91	97	6.8	6.2	6.1	6.1
" " neutralised*	16	67	91	100	6.8	6.2*	6.8	6.8
" " "	13	54	89	102	6.8	6.4*	6.6*	6.8
Control (no silica); not neutralised	14	42	71	99	6.8	6.6	6.4	6.2

It is difficult to understand why the new sample of commercial lactose should, when using double the quantity, give approximately the same amount of carbon dioxide as the old sample. A test with increasing amounts of lactose showed that the fermentation proceeded very steadily during the first three days, irrespective of the variation in the amount of sugar present.

Days	1	2	3	4	5
Lactose, 0.2 gram	20	46	73	104	120
" 0.4 gram	21	50	75	123	165
" 0.6 gram	20	52	77	118	158

Conclusions.

The mineral colloids such as kieselguhr, fuller's earth, asbestos, precipitated silica, kaolin, the organic colloid agar-agar and charcoal all acted as accelerating agents in hastening the fermentation of the slowly fermenting sugar, lactose, by the high-temperature organism.

These belong to the class of electro-negative colloids, but the electric charge does not appear to be responsible for the accelerating effect. The electro-positive colloid, precipitated ferric hydrate, accelerated the fermentation, while aluminium hydrate retarded it.

The acceleration was greater with a larger amount of colloid but it was not proportional; 0.2% of colloid was not twice as effective as 0.1%.

Judging by the behaviour of agar-agar, the colloids in the insoluble or gel state are more effective than when in the dissolved or sol condition. Gelatine, a typical colloid, neither hastened the fermentation of lactose nor of itself.

The precipitated phosphates of iron and aluminium acted as accelerating colloids; one lot of ferric phosphate was exceedingly active.

The presence of soluble salts of calcium in the fermenting fluid retarded the fermentation.

I am indebted to Mr. W. W. L'Estrange for much kindly assistance.

AUSTRALIAN NEMESTRINIDAE. (DIPTERA).

By G. H. HARDY.

(Thirteen text-figures.)

[Read 29th October, 1924.]

The key to the species of the genus *Trichophthalma* given below, was found amongst the manuscript papers of the late Arthur White,* now in the possession of Dr. E. W. Ferguson. The information derived from this source has afforded considerable assistance in identifying species of the family, as the identity of some may not have been readily discovered from the descriptions alone. In White's original manuscript the order of the various lines is not in accordance with the more simplified form given here, but the wording is the same.

White's key to the species of the genus Trichophthalma, *based upon types and other specimens in the British Museum Collection.*

1. Abdomen spotted 2
   Abdomen with two longitudinal stripes 3
   Abdomen with one longitudinal stripe 4
   Abdomen with cross bands 5
   Abdomen with both dorsal lines and cross bands 6
   Abdomen without either bands or stripes 7
2. Abdomen with from two to six white spots; little species .. *albimacula* Walk.
   Abdomen with a row of dark central spots .. .. *novae-hollandiae* Macq.
3. Abdomen brown, thorax and abdomen each with two yellow stripes; rather small species .. .. *leucophaea* Walk.
4. Abdomen pale yellow or grey with a broad black central stripe and black side margins .. .. *bivitta* Walk.
   Abdomen yellow with a very broad black stripe; thorax black, fringed with yellow hairs; a very small slender species .. .. *bivittata* Westw.
   Abdomen bright orange with black dorsal stripe; thorax with a median stripe .. .. *fulva* Walk.
   Abdomen red-brown, with an indistinct black dorsal stripe; wings with the costal half brownish .. .. *costalis* Westw.
5. Abdomen covered with pale grey pubescence, crossed by two narrow black bands; wings hyaline .. .. *primitiva* Walk.
   Abdomen black, with two narrow yellow bands; thorax with two distinct yellow stripes .. .. *laetilinea* Walk.

*For particulars of this MS., see Notes on Australian Bombyliidae, Hardy, Proc. Roy Soc. Tasmania, 1923, p. 72.

Resembles *laetilinea,* but much smaller, markings distinct and wings much paler; in one specimen the abdominal bands are replaced by yellow spots .. .. *richardoae* Licht.

6. Wings remarkably short. Abdomen yellow with four black cross-bands and black dorsal stripe .. .. *variolosa* Licht.

7. Uniformly red-brown; wings hyaline with costa suffused red-brown .. .. *funesta* Walk.

Uniform dark black; thorax with pale yellow hairs on sides; wings hyaline with base dark brown; large species .. .. *nigripes* Macq.

Uniform dull black; sides of thorax, scutellum and apex of abdomen with fulvous hairs; large species (unknown to me) .. .. .. *scapularis* Big.

Entirely dull brownish; wings hyaline with costa narrowly brown; median-sized species .. .. *obscura* Westw.

Small dark species with wings suffused dark brown (the identification of this species is queried in the B. M. collection) .. .. *fuscipennis* Thoms.

The types of the following species are not to be found in the British Museum Collection: *albitarsis, aurora* and *degener* Walker.

Acknowledgements. The material studied for the purpose of this paper includes the specimens in the collections of Dr. E. W. Ferguson, Miss V. Irwin Smith, Mr. A. J. Nicholson, and the Macleay, Australian, National and Queensland Museums. Specimens in my own collection have been kindly supplied by Dr. R. J. Tillyard, Dr. A. J. Turner, Mr. R. Illidge, and Mr. G. Lyell; from the last-named the only species described here as new was received. Specimens of my own collecting come from Western Australia, Tasmania and New South Wales.

Family NEMESTRINIDAE.

The characters that most readily distinguish this family are to be found in the venation, a detailed account of which is given under each genus, where it will be noted the one outstanding feature in common to all genera, and unique to the family, consists of a secondary diagonal vein composed of portions of various veins. The anal vein is free. The epodium is pulvilliform.

Key to the genera of Australian Nemestrinidae.

1. Proboscis well developed, long. Cubital vein forked and independent of the radial vein .. .. *Trichophthalma*

Proboscis small or vestigial. If the cubital vein is forked, then joined directly to, or by a cross-vein with the radial 2

2. Cubital vein forked; the upper branch may be obsolete, but if so this can be recognised by the presence of the cross-vein between the cubital and radial veins 3

Cubital vein never forked or joined by a cross-vein with the radial 4

3. Upper branch of the cubital vein complete and joined at nearly half its length with the radial vein by a cross-vein .. .. *Exeretoneura*

Upper branch of the cubital vein vestigial and joined by a cross-vein with the radial at its base .. .. *Trichopsidea*

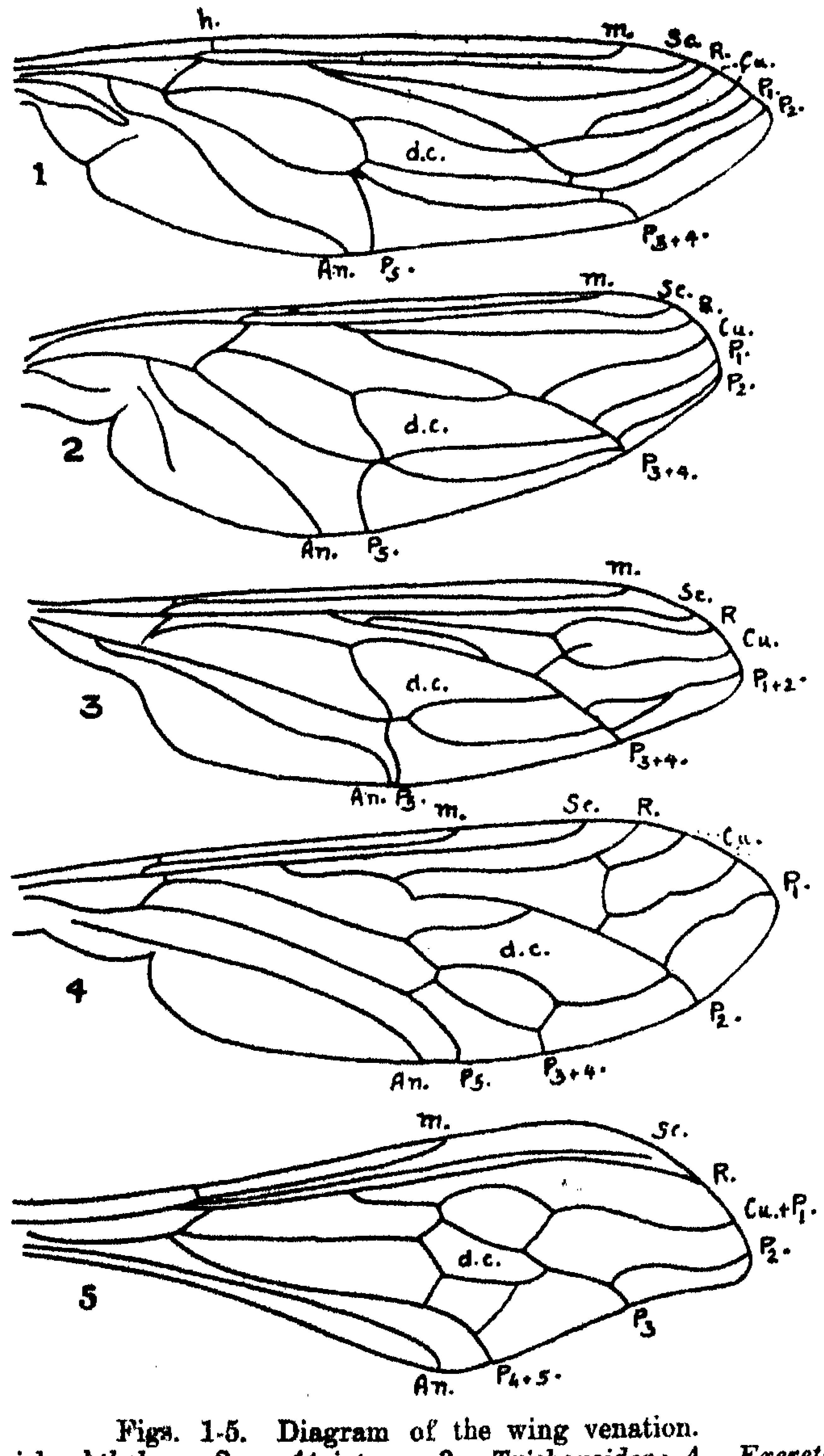
4. Cubital vein united with the first postical, and also the fourth and fifth posticals united before reaching the wing margin .. .. .. *Nycterimorpha*

Cubital and fourth postical veins free, or at most the latter meets the third postical at the wing margin .. .. *Atriatops*

Genus TRICHOPHTHALMA Westwood. (Figs. 1, 6 and 7.)

Westwood, Lond. Edin. Phil. Mag., vi., 1835, 448; Lichtwardt, Deut. Ent. Zeit., 1910, 371; White, Proc. Roy. Soc. Tasmania, 1914, 65.

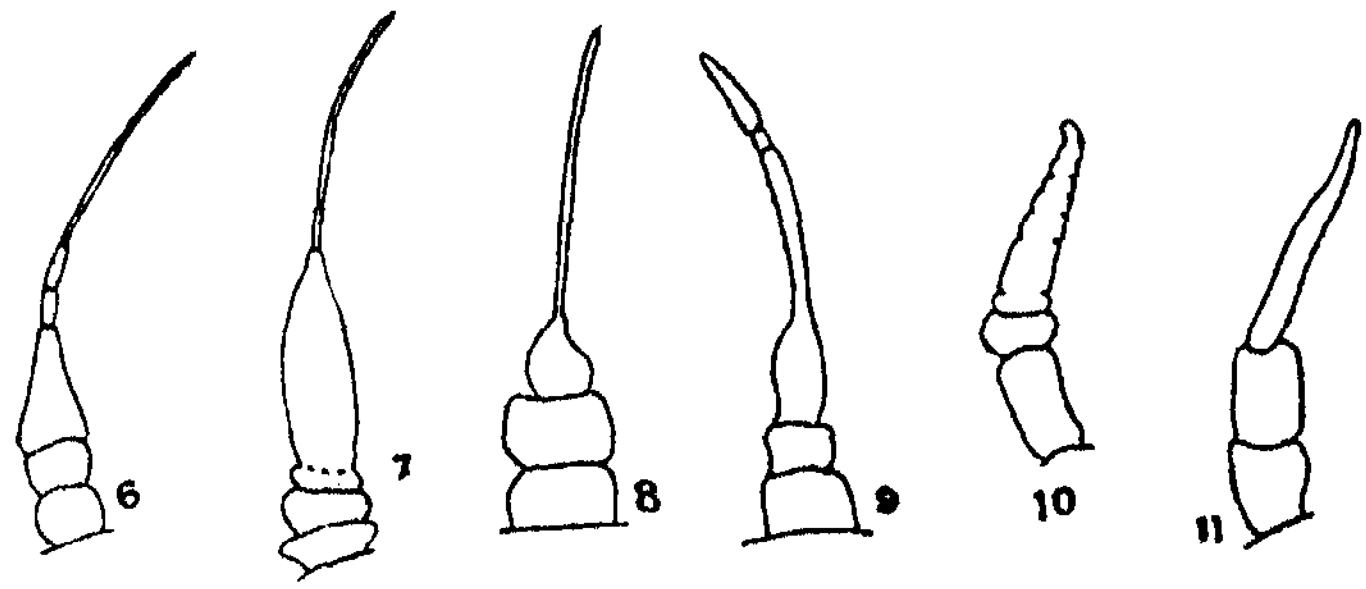
Characters.—Proboscis long, well developed. Antennae with three segments



Figs. 1-5. Diagram of the wing venation.

1. *Trichophthalma;* 2. *Atriatops;* 3. *Trichopsidea;* 4. *Exeretoneura;* 5. *Nycterimorpha.* *h.* humeral vein; *m.* mediastinal vein; *Sc.* subcostal; *R.* radial; *Cu.* cubital; P_1 first postical vein (second and subsequent postical veins are denoted by suitable figures, P_2, etc. and when two of these run together they are denoted as P_{4+5}, etc.); *An.* anal vein; *d.c.* discal cell.

and a conspicuously jointed arista. Wings with long mediastinal and subcostal veins; radial vein free; the cubital forked; the first and second postical veins reaching the wing margin anterior to the apex; third postical branching from the second and anastomosing with the fourth. The complex diagonal vein is composed of the extreme base of the radial, the basal half of the cubital, the



Figs. 6-11. Diagram of the antennae.
6, 7. The two forms of the antennae found in genus *Trichophthalma;* 8. *Atriatops;* 9. *Trichopsidea;* 10. *Exeretoneura;* 11. *Nycterimorpha.*

vein at the apex of the discal cell, the base of the second postical, the whole of the third and the tip of the fourth posticals. The fourth and fifth posticals rise close together at the apex of the second basal cell.

Type, *T. costalis* Westwood. Australia.

Key to the species of the genus Trichophthalma.

1. Third segment of the antennae short and conical, simple 2
   Third segment of the antennae longer, with a constricted base that appears like another segment in the antennae 5
2. Abdomen without stripes, at most with a median line of spots 3
   Abdomen with distinctly one median and a pair of lateral stripes which are usually not interrupted 4
3. A brown species, invariably with a median line of abdominal spots .. .. *punctata* Macq.
   A brown species with very conspicuous long white pubescence at base of the abdomen .. .. *costalis* Westw.
   A large uniformly brown species, without pubescence of a contrasting colour .. .. *novae-hollandiae* Macq.
   A large slate-grey species with yellow pubescence at sides of the thorax and fringing the scutellum .. .. *nigripes* Macq.
4. A species with brown or brownish abdomen .. .. *fulva* Walk.
   A grey species with three broad black or brown stripes on thorax as well as on the abdomen .. .. *degener* Walk.
5. Abdomen grey with three black longitudinal stripes and at least a little red pubescence .. .. *rosea* Macq.
   Abdomen grey with three black longitudinal stripes and also with narrow black bands at segmentations, thus dividing the grey area into spots. .. .. *albimacula* Walk.
   Abdomen with two or three narrow bands of golden pubescence situated at the apex of the segments .. .. *laetilinea* Walk.
   Abdomen grey, with at least two narrow black bands on abdomen and without longitudinal stripes .. .. *primitiva* Walk.

Note.—As far as yet ascertained, those species that have a superficial resemblance to each other (i.e., not one of affinity), can be separated by means of

the third antennal segment. In one this is short and conical (see fig. 6), in the other it is not only much longer than broad, but is also constricted near the base, which character gives the antennae the appearance of containing four joints and an arista (see fig. 7). There are no known structural characters, other than those of the antennae, suitable for the determination of the species and on this account the means of identification still depends chiefly upon the outstanding characters of colour and colour-markings. The described forms readily fall into six groups, each of which contains species of allied characters.

Group 1.—*costalis*, *punctata* and *fulvus*.
Group 2.—*novae-hollandiae* and *nigripes*.
Group 3.—*degener*, *heydenii* and probably *leucophaea*.
Group 4.—*rosea*, *bivittata*, *variosa*, *eques* and *albimacula*.
Group 5.—*laetilinea* and probably *richardoae*.
Group 6.—*primitiva*.

The first three groups have a conical third antennal segment; the last three have this segment more elongate and constricted at the base. The third and fourth groups have very similar colour pattern but they differ in shape as well as in the antennae; moreover, the proboscis is often much longer in the former.

Lichtwardt refers to two species for which short descriptions are given but no names. Several further and apparently new species are represented in various collections, but it is not considered expedient to describe these at the present time.

TRICHOPHTHALMA COSTALIS Westwood.

Westwood, Lond. Edin. Phil. Mag., vi., 1835, 448, and Isis, ii., 1838, 86; Lichtwardt, Deut. Ent. Zeit., 1910, 372.—*Rhyncocephalus costalis* Newman, Entom., i., 1841, 220.—? *T. obscūra* Westwood, l.c., 1835, 448, and 1838, 86.—*T. albitarsis* Walker, Trans. Ent. Soc. Lond., iv., 1857, 134; Schiner, Reise Novara Dipt., 1868, 112; Lichtwardt, l.c., 1910, 381.—*T. fuscipennis* Thomson, Eugenies Resa Dipt., 1869, 447; Lichtwardt, l.c., 1910, 385.

Synonymy.—*T. obscura* Westwood was described without a locality, but a specimen in Dr. Ferguson's collection was identified as such by White; unfortunately, this specimen is now in very bad repair (the head and abdomen are missing), but it appears to be identical with some specimens independently identified by me from the description as *T. albitarsis* Walker. I believe *T. costalis* and *T. fuscipennis* also belong here.

Note.—Readily recognised by the soft, white and long pubescence at the base of the abdomen. The indistinct black dorsal stripe of the abdomen, referred to by White in his key, is perceptible on specimens which are inferior in condition; one specimen in Dr. Ferguson's collection has a median line of abdominal spots.

Hab.—New South Wales: Kendall, Leura and Blackheath. From the last-named locality there are five males and one female in my collection taken on the 23rd and 24th November, 1919, all hovering under the same tree. The specimen identified by White as *T. obscura* is from Long Bay, near Sydney, taken on the 17th November, 1913. Como and Wentworth Falls (A. J. Nicholson). Victoria: Oakley, March, 1919 (C. E. Cole), in the National Museum. Queensland: Large specimens from Stradbroke and Bribie Islands, Tambourine Mt. and Brisbane are in the Queensland Museum. Western Australia: A specimen from Hamel in the Queensland Museum.

TRICHOPHTHALMA ALES Newman.

Rhyncocephalus ales Newman, Entom., i., 1841, 220.—*Trichophthalma ales* Lichtwardt, Deut. Ent. Zeit., 1910, 375.

From the description it is not possible to determine the identity of this species; nevertheless, the name is placed here as it may belong to either *T. costalis* or a closely allied form.

TRICHOPHTHALMA PUNCTATA Macquart.

Hirmoneura punctata Macquart, Dipt. Exot. suppl. 1, 1846, 101.—*Trichophthalma punctata* Lichtwardt, Deut. Ent. Zeit., 1910, 376.—*Hirmoneura nigriventris* Macquart, Dipt. Exot. suppl. 4, 1850, 98, Pl. ix., fig. 9.—*Trichophthalma quadricolor* Walker, List Dipt. Brit. Mus., ii., 1849, 234; Lichtwardt, l.c., 380.—*Hirmoneura novae-hollandiae* Macquart, Dipt. Exot. suppl. 4, 1850, 99 (*nec* Macquart, 1840).—*Trichophthalma novae-hollandiae* White, Proc. Roy. Soc. Tasm., 1914, 65 (*nec* Macquart, 1840).

Synonymy.—Under *Trichophthalma novae-hollandiae*, there will be found some remarks indicating a confusion caused by Macquart, who referred two species under one name. One, a male from Tasmania, is undoubtedly the same as a species described under the same specific name by White. As all the above species are attributed to specimens from Tasmania, where only one species belonging to the genus is known, doubtless the synonymy is correct.

Note.—As already pointed out by White, this species is somewhat variable and the colour markings differ in the two sexes; the brownish colour on the male is rather obscure.

Hab.—Apparently restricted to Tasmania, *T. punctata* has a wide distribution over the island and is abundant during the summer months. Twenty-one males and twelve females, also a pair taken *in copula* are in my collection; they are from South Bruni Island, Garden Island, Hobart, Wedge Bay, Dunalley, Mt. Maria and Wynyard; the dates range from December to March. At Strahan, in the west, a specimen was seen by me on two occasions during February, 1924. White referred to the species as occurring on the mainland of Australia, but he was evidently misled by the resemblance to the species now known as *T. fulva*.

TRICHOPHTHALMA FULVA Walker.

Walker, List Dipt. Brit. Mus., ii., 1849, 235; Lichtwardt, Deut. Ent. Zeit., 1910, 380.—*T. ochropa* Thompson, Eugenies Resa Dipt., 1869, 477; Lichtwardt, l.c., 384.

Synonymy.—White, who has evidently examined Walker's type, has identified a specimen in Dr. Ferguson's collection as being this species. I believe Thompson's name refers to the same. A dark greyish-brown female in the National Museum is identified by Miss Ricardo as "probably *Tr. quadricola* Walker."

Note.—The male is readily distinguishable from the Tasmanian *T. punctata* by the decidedly red-brown abdomen. The black median abdominal stripe is about half the width of the brown stripes on each side of it. In both sexes the narrow black lateral stripes as well as the median stripe may be interrupted to form spots.

Hab.—Western Australia (Walker), New South Wales, Victoria and Queensland.

TRICHOPHTHALMA NOVAE-HOLLANDIAE Macquart.

Hirmoneura novae-hollandiae Macquart, Dipt. Exot., ii., 1840, 19, Pl. ii., fig. 7; also ? suppl. i., 1846, 101 (*nec* suppl. 4, 1850).—*Trichophthalma novae-hollandiae* Schiner, Reise Novara Dipt., 1868, 110; Lichtwardt, Deut. Ent. Zeit., 1910, 373 (*nec* White, 1917).—*T. funesta* Walker, List Dipt. Brit. Mus., ii., 1849, 231; Lichtwardt, ibid., 377.—*Rhyncophalus gigas* Newman, Entom., i., 1841, 220.—*Trichophthalma gigas* Lichtwardt, ibid, 375.

Synonymy.—There is a considerable amount of confusion with regard to this species, which appears to have been described by Macquart from the same form, named later *T. funesta* by Walker. In 1846 Macquart described a smaller specimen, without locality, recording it as a male, the original being a female, and in 1850 he duplicated this action, describing the male from Tasmania. It is certain that neither of the males belong to the same species as the female, and the Tasmanian male is referable to *T. punctata*. From the description I believe *Rhyncophalus gigas* Newman is this species.

Note.—This is a large species of uniform reddish-brown colour.

Hab.—Victoria, New South Wales, Queensland, Stradbroke Island, Torres Straits and Western Australia; December and January. This species is represented in most collections, and a female in mine is from Barrington Tops, December, 1921.

TRICHOPHTHALMA NIGRIPES Macquart.

Hirmoneura nigripes Macquart, Dipt. Exot., ii., 1840, 20.—*Trichophthalma nigripes* Lichtwardt, Deut. Ent. Zeit., 1910, 374.—*T. scapularis* Bigot, Ann. Soc. Ent. France (6), i., 1881, 18.

Synonymy.—Macquart's species was described without a locality, but Lichtwardt records it from Australia and adds Bigot's name as a synonym.

Note.—A species resembling *T. novae-hollandiae* but of a slate-like colour and containing yellow hair at the sides of the thorax and base of the abdomen.

Hab.—New South Wales: Eccleston, Kendall, 1 ♂, 3 ♀ in Dr. Ferguson's collection. Queensland: Bribie Island, November, 1918, Stradbroke Island, December, 1913, 1 ♂ and 2 ♀ with colour intermediate between the typical form of this species and *T. novae-hollandiae.*

TRICHOPHTHALMA DEGENER Walker.

Trichophthalma degener Walker, List Dipt. Brit. Mus., ii., 1849, 233; Lichtwardt, Deut. Ent. Zeit., 1910, 379.

Note.—This species belongs to a group that has a superficial resemblance to the *T. rosea* series, but it can be readily distinguished by the conical third antennal joint, and usually the proboscis is longer. On the thorax there are three very broad brown or black stripes that occupy nearly the whole surface; the intermediate grey stripes are very narrow and not interrupted. The scutellum and abdomen are brown or black, the latter has a pair of very narrow grey stripes. The eyes are separated in both sexes.

Hab.—Western Australia: Perth, 9th November, 1912, a pair taken *in copula;* also a male in Dr. Ferguson's collection.

TRICHOPHTHALMA HEYDENII Jaennicke.

Hirmoneura heydenii Jaennicke, Abh. Senck. Nat. Ges., vi., 1867, 336, Pl. xliii., fig. 7.

Note.—Very similar to *T. degener*, but the outer thoracic stripes are interrupted.

Hab.—Western Australia; two specimens in the Australian Museum apparently belong to this species and are labelled "K.G.S." (King George Sound).

TRICHOPHTHALMA LEUCOPHAEA Walker.

Trichophthalma leucophaea Walker, List Dipt. Brit. Mus., ii., 1849, 233; Lichtwardt, Deut. Ent. Zeit., 1910, 379.

Note.—Distinguished from the two previous species by having the brown thoracic stripes considerably narrower.

Hab.—Western Australia; three faded specimens in the National Museum.

TRICHOPHTHALMA ROSEA Macquart.

Hirmoneura rosea Macquart, Dipt. Exot., suppl. 1, 1846, 100.—*Trichophthalma rosea* Lichtwardt, Deut. Ent. Zeit., 1910, 376.—*T. aurora* Walker, List Dipt. Brit. Mus., ii., 1849, 232; Lichtwardt, ibid, 381.—*T. montanea* Schiner, Reise Novara Dipt., 1868, 110.—? *T. bivitta* Walker, Trans. Ent. Soc. Lond., 1857, 135; Lichtwardt, ibid, 381.

Synonymy.—*H. rosea* Macquart, *T. aurora* Walker and *T. montanea* Schiner undoubtedly refer to one species, which is readily distinguished from its allies by red or rosy pubescence that is invariably abundant on the male and occurs to a limited extent on the female. A male specimen was identified by White as *T. bivitta* Walker, but it is uncertain whether this identification can be correct, as the occurrence of red pubescence is omitted from the description of that species. The figure in Froggatt's "Australian Insects" named *T. eques* appears to represent this species.

Note.—This is one of a series of closely allied forms that are apparently quite distinct species; it occurs abundantly at La Perouse, Botany Bay, and is the commonest Nemestrinid around Sydney; it has not been seen from elsewhere. Moreover, none of the other species of the series has been seen from this locality.

Hab.—New South Wales: Sydney, La Perouse; a series of eighteen males and four females were taken by me during the months of August and September in 1919 and 1920; the species occurs on the wing for four or five weeks only. Specimens are in various collections.

TRICHOPHTHALMA BIVITTATA Westwood.

Westwood, Phil. Mag. Lond. and Edinb., vi., 1835, 448; Isis, ii., 1838, 86; Lichtwardt, Deut. Ent. Zeit., 1910, 371.

Note.—From the description this species appears to belong to the *T. rosea* series, but I am not able to place it with certainty. According to Lichtwardt the type is in inferior condition and he suggests that it is the same as *T. bivittata* Thomson; I do not think this suggestion can be correct as Westwood states the thorax is cinereous and on Thompson's species the grey is restricted to two lines. Possibly it was described from a specimen very close to *T. rosea* Macquart but differing in little more than the absence of red pubescence.

TRICHOPHTHALMA VARIOLOSA Lichtwardt.

Lichtwardt, Deut. Ent. Zeit., 1910, 386.

Note.—A specimen in the South Australian Museum, Adelaide, has been tentatively identified by me as this species, but it is not available for study at the time of writing this paper. This species is closely allied to *T. rosea* Macquart.

TRICHOPHTHALMA EQUES Schiner.

Schiner, Reise Novara Dipt., 1868, 110.

Note.—A species closely allied to *T. rosea* Macquart, from which it differs apparently only in the markings of the thorax and the absence of red pubescence. A single female specimen in Dr. Ferguson's collection conforms most closely to Schiner's description, and a series of eight specimens in the Queensland Museum from Brisbane (November) probably belongs to the same form. These contain on the thorax a median black stripe, a pair of lateral stripes interrupted by the transverse suture and extending to only half the length of the thorax, and on the extreme lateral border, lying along the post-alar callus, there is another pair of black stripes. Dr. Ferguson's specimen is from North Queensland, but Schiner's was described from Sydney.

TRICHOPHTHALMA ALBIMACÚLA Walker.

Walker, List Dipt. Brit. Mus., ii., 1894, 234; Lichtwardt, Deut. Ent. Zeit., 1910, 380.—*T. bivittata* Thomson (*nec* Westwood), Eugenies Resa Dipt., 1869, 476; Lichtwardt, ibid, 382.

Synonymy.—Judging from the original description and White's notes on the type, it seems probable that Walker and Thompson described the same species, Walker's specimen being of an unusually small size.

Note.—A male in my collection and a female in Dr. Ferguson's, apparently belong to this species which differs from *T. rosea* by having the light portions of the thorax limited to two narrow stripes which converge slightly towards the scutellum; the abdomen has narrow bands at the segmentations thus dividing the lighter portions into large, more or less rectangular spots; there is no red pubescence.

Hab.—New South Wales: Murrumbidgee, August, 1921, female; Waterfall, September, 1914, a male taken by Dr. R. J. Tillyard.

TRICHOPHTHALMA LAETILINEA Walker.

Walker, Trans. Ent. Soc. Lond., iv., 1857, 134; Lichtwardt, Deut. Ent. Zeit., 1910, 381.

Note.—A handsome black species with a pair of median grey stripes which converge and are confluent towards the scutellum; also with a converging pair of light lateral fringes composed of long pubescence. The abdomen has a narrow transverse band of yellow pubescence at the apex of three segments. In Dr. Ferguson's collection there is a pair of very small specimens that differ in minor details from the larger ones.

Hab.—New South Wales: Waterfall, a female taken by Dr. R. J. Tillyard, 15th September, 1914. Further specimens are from Blue Mountains and Sydney. Victoria: Mallee Scrub, Western District, 1884, and Narracan, November, 1896 (W. Kershaw), 1 ♂, 2 ♀.

TRICHOPHTHALMA RICHARDOAE Lichtwardt.

Lichtwardt, Deut. Ent. Zeit., 1910, 385.

Note.—This species, described from Adelaide, is unknown to me.

TRICHOPHTHALMA PRIMITIVA Walker.

Walker, Trans. Ent. Soc. Lond., iv., 1857, 134; Lichtwardt, Deut. Ent. Zeit., 1910, 381.—*T. tabanina* Thomson, Eugenies Resa Dipt., 1869, 476; Lichtwardt, ibid, 384.

Synonymy.—This synonymy is probably correct; Walker's description is traceable to a species well known to me and Thomson's description conforms rather well to the same.

Note.—A small grey species with rather obscure brownish elongate spots on the thorax arranged like interrupted stripes; there are, however, more spots than would be indicated by Thompson's description. The abdomen has two definite transverse bands of black pubescence and a third more or less obscure one.

Hab.—New South Wales: La Perouse, two males taken respectively on the 17th August, 1919, and 21st August, 1920, in association with *T. rosea,* visiting the early spring flowering shrubs; Woy Woy, 8 ♂, 3 ♀ (Nicholson collection).

Genus ATRIATOPS Wandolleck. (Figs. 2, 8.)

Colax Wiedeman, Analecta Entom., 1824, 18, Pl. i., fig. 8; also Auss, Zweifl. Ins., ii., 1830, 260, Pl. ix., fig. 11 (Name preoccupied by Hubner, 1816, and Curtis, 1827).—*Atriatops* Wandolleck, Entom. Nachrichten, xxiii., 1897, 245; Lichtwardt, Deut. Ent. Zeit., 1910, 649.

Characters.—The mouth parts are vestigial, or at least very small. Antennae very small, three-jointed and with a long arista. Wings with long mediastinal and subcostal veins, radial vein free, the cubital not forked, the two first postical veins terminate at the apex of the wing, the third and fourth posticals terminate together at the wing margin. The complex diagonal vein is composed of the base of the radial, a considerable length of the cubital which is fused for a short distance with the vein bordering the discal cell, the vein at the apex of the discal cell, the base of the second, the whole of the third and the extreme apex of the fourth postical veins. The fourth and fifth postical veins rise from the second basal cell. This venation differs from that of the genus *Trichophthalma* chiefly in the cubital vein not being forked.

Type, *C. javana* Wiedemann. Java.

ATRIATOPS JAVANA Wiedemann.

Colax javana Wiedemann, Anal. Entom., 1824, 18, Pl. i., fig. 8; also Auss. Zweifl. Ins., ii., 1830, 26, Pl. ix., fig. 11.—*Atriatops javana* Wandolleck, Entom. Nachrichten, xxiii., 1897, 246, fig. 1; Lichtwardt, Deut. Ent. Zeit., 1909, 649.

Note.—Lichtwardt records this species from Cape York, Townsville and Palmerston; there are specimens undoubtedly belonging to this genus from various parts of Queensland in several collections and these are attributed to this species. They agree better with the illustration by Westwood (Walker, Ins. Saund. Dipt., Pl. v., fig. 4) for which the name *A. westwoodi* was proposed by Lichtwardt who, however, based his description upon a New Guinea specimen. Until further material and information are available it cannot be ascertained if the specimens referred here are *A. javana, A. westwoodi* or yet a third species; they are dated November.

Genus TRICHOPSIDEA Westwood. (Figs. 3, 9.)

Westwood, Trans. Ent. Soc. Lond., ii., 1839, 151, Pl. xiv., fig. 9; Wandolleck, Entom. Nachrichten, xxiii., 1879, 250, fig. 6.

Characters.—The mouth parts contain a very short proboscis which scarcely protrudes beyond the abundant long hair of the face. The antennae are minute and terminate in a short, apparently jointed style. The wings have long mediastinal and subcostal veins; the radial vein is joined to or near the base of the vestigial (sometimes obsolete) upper branch of the cubital fork by a cross-vein; the first and second postical veins anastomose apically for a considerable distance and terminate at about the apex of the wing; the third postical vein joins the apex of the fourth; the complex diagonal vein is composed of the base of the radial and cubital veins (the latter is partly coincident with a portion of the vein bordering the discal cell), the base of the first and second, the whole of the third and apex of the fourth postical veins; the fourth postical vein rises from the discal cell; the fifth postical and anal veins are approximate at the margin of the wing. The four outstanding features of this venation consist of the cross-vein between the radial and cubital veins, the closed second posterior cell, the fourth postical vein rising from the discal cell, and the almost closed anal cell.

Type, *T. oestracea* Westwood. Australia.

TRICHOPSIDEA OESTRACEA Westwood.

Westwood, Trans. Ent. Soc. Lond., ii., 1835, 152, Pl. xiv., fig. 9; Macquart, Dipt. Exot. suppl. 1, 1846, 107; Walker, List Dipt. Brit. Mus., ii., 1849, 235; Wandolleck, Ent. Nachrichten, xxiii., 1897, 250, fig. 6; Lichtwardt, Deut. Ent. Zeit., 1909, 647; and 1910, 387; White, Proc. Roy. Soc. Tas., 1916, 260; Lichtwardt, Ann. Mus. Nat. Hung., xvii., 1919, 277.

Hab.—Queensland: Toowoomba; 15.3.21, 2 females (collected by Barnard), and another without a label, in the Queensland Museum; Victoria: Bunyip, 2 females; Western Australia, 3 females in the National Museum. Macquart, Walker and White give Tasmania as a locality, from which State White says there are specimens in the British Museum.

Genus EXERETONEURA Macquart. (Figs. 4, 10.)

Macquart, Dipt. Exot. suppl. 1, 1846, 105; White, Proc. Roy. Soc. Tas., 1914, 63, text-fig. 8.

Characters.—Mouth parts short and with a thickened extremity, in which they differ from all other genera of the family. Antennae with the third joint composed of several compact segments and without the differentiated style or arista that is in other genera. Wings with a venation consisting of the mediastinal and subcostal veins, which do not reach so far towards the apex as in the other genera; the radial vein joined to about the middle of the upper branch of the cubital by a cross-vein; the first postical vein runs to about the apex of the wing; the second postical forms the apex of the complex diagonal vein which also consists of the base of the radial and cubital veins (the latter being coincident with a portion of the vein bordering the discal cell) and the vein at the apex of the discal cell. The third and fourth postical veins anastomose before reaching the wing-border. The third postical vein rises from the discal cell and the fourth from the second basal cell. The fifth postical is free.

Many of the above characters are considered to be of a primitive nature; the most conspicuous being the composition of the diagonal vein which ends in the second postical vein. The veins that reach the wing-border anterior to the apex are more widely distributed than in the preceding genera. Moreover, the

antennae and proboscis are generalized in structure, a statement that may also be applied to the abdomen, which is longer than that in the other genera, and is more or less parallel-sided.

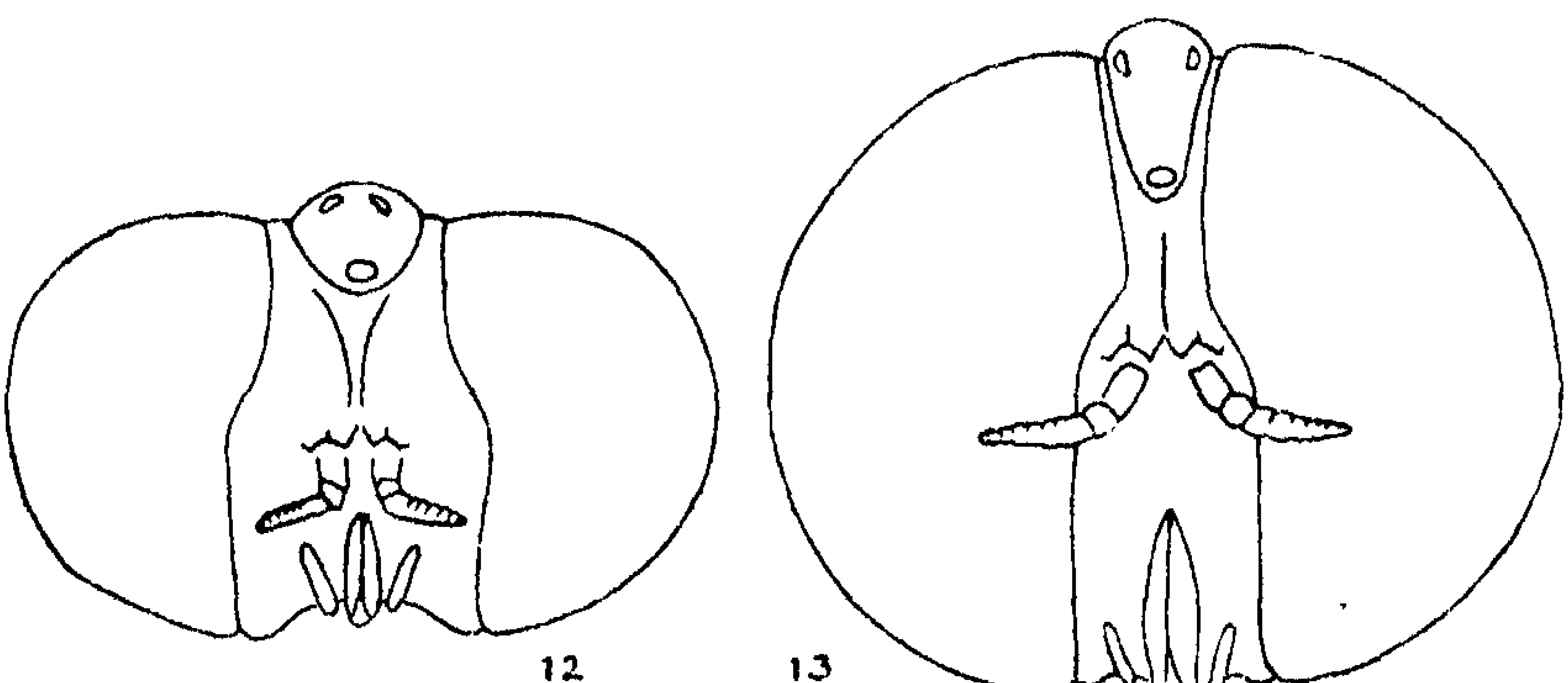
Type, *E. maculipennis* Macquart. Tasmania.

EXERETONEURA MACULIPENNIS Macquart. (Fig. 12.)

Macquart, Dipt. Exot. suppl. 1, 1846, 106, Pl. ix., fig. 6; Lichtwardt, Deut. Ent. Zeit., 1909, 651; White, Proc. Roy. Soc. Tas., 1914, 63, fig. 8.

Note.—Distinguishable from *E. angustifrons*, n.sp., by the width of the head between the eyes; the front near the antennae is about as wide as long.

Hab.—Tasmania: Bellerive, 3 ♂ taken by sweeping in long grass on the sand-dunes at Bellerive beach on the 14th March, 1917; 1 ♂, 1 ♀ from the same locality in the National Museum (C. E. Cole); Cradle Mt., Pencil Pine Creek, 1 ♂, 17th January, 1917. New South Wales: Mt. Kosciusko, February and March, 1920, 1 ♂ and 3 ♀ in Dr. Ferguson's collection; other specimens have also been taken on this Mountain; Barrington Tops, 1 ♂, 1 ♀ (A. J. Nicholson).



Figs. 12-13. Diagram of the heads in the genus *Exeretoneura*. 12. *E. maculipennis* Macquart; 13. *E. angustifrons*, n.sp.

EXERETONEURA ANGUSTIFRONS, n.sp. (Fig. 13.)

Differs from *E. maculipennis* Macquart by having a very narrow front, which, near the antennae, does not exceed half its length. Head black, two tufts of yellow hairs above the antennae and the hair on the face also yellowish. Thorax blackish-brown and with three black median stripes; the majority of the hairs are yellowish. Scutellum brownish-black. Abdomen black, which colour merges into yellowish-brown at the apex on the female only; pubescence yellowish and white; venter yellow-brown. Legs and veins of the wing yellowish. Male considerably more pubescent than the female, and its front narrower. Length: ♂. 15 mm.; ♀. 19 mm.

Hab.—Victoria: Gisborne, holotype ♂ and allotype ♀, a pair taken *in copula*, by Mr. G. Lyell, 11.3.1917; Gippsland, 1 ♂, 1 ♀, paratypes in the National Museum. New South Wales: 1 ♂ paratype from Ebor, taken by Dr. A. J. Turner, 8.1.1914, in the Queensland Museum.

NYCTERIMORPHA Lichtwardt. (Figs. 5, 11.)

Lichtwardt, Deut. Ent. Zeit., 1909. 648, fig. 6.

Characters.—Proboscis not apparent, palpi conspicuous. Antennae with two equally short basal segments and a slender long third segment which is apparently but very obscurely segmented. Wings with the mediastinal vein reaching to about the middle of the costa; subcostal vein not quite reaching the wing margin; radial vein free, but branching from the subcostal near the humeral cross-vein; cubital vein not forked and apically anastomosing with the first postical vein thus closing the first posterior cell. The second postical vein reaches the margin just before the apex of the wing and the third postical branches from the second. The complex diagonal vein is composed of the base of the cubital vein, the median transverse vein, part of the vein bordering the discal cell, the base of the second and the whole of the third postical veins. The fourth postical rising from the discal cell runs into the fifth.

Type, *N. speiseri* Lichtwardt. Queensland.

NYCTERIMORPHA SPEISERI Lichtwardt.

Lichtwardt, Deut. Ent. Zeit., 1909, 648, fig. 6.

Hab.—Queensland: Cairns (Lichtwardt); Tambourine Mt. (W. H. Davidson) in the Queensland Museum. This is a single specimen that was originally preserved in spirit.

Genus NYCTERIMYIA Lichtwardt.

Lichtwardt, Deut. Ent. Zeit., 1909, 648.

Nycterimyia has been recorded from Queensland and is apparently not represented in any Australian collection; it should be readily recognised by the presence of a cross-vein between the subcostal and radial, in addition to the one between the radial and cubital veins. The cubital vein is simple, not branched, the first postical apparently is absent and the fourth joins the third to form the apex of the complex diagonal vein. These characters are deduced from Lichtwardt's figure.

Type, *Trichopsidea dohrni* Wandolleck. Sumatra.

NYCTERIMYIA HORNI Lichtwardt.

Lichtwardt, Ent. Mitt., i., 1912, 27, fig. 1.

Hab.—Queensland: Kuranda (Lichtwardt).

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TWO NEW HEMIPTERA FROM NEW SOUTH WALES.

By Herbert M. Hale.

(*Communicated by A. J. Nicholson, M.Sc.*)

(Plates xlvii.-xlviii.)

[Read 26th November, 1924.]

A Notonectid for which it is necessary to erect a new genus, and a Saldid from the Blue Mountains, are herein dealt with. These two species were included in a series of aquatic and semi-aquatic Hemiptera taken in New South Wales by Mr. A. J. Nicholson, to whom I am indebted for the opportunity of examining these bugs.

Family NOTONECTIDAE.

Subfamily NOTONECTINAE.

The backswimmer is of special interest for, although only a few specimens were taken, two distinct forms are represented. The one is a melanochroic form with completely developed hemelytra and metathoracic wings, and a large scutellum. The other variety is degenerate; the dorsum is largely luteous, the hemelytra are for the most part devoid of pigment, show no trace of claval or membranal suture, and have a greatly reduced "membrane," while metathoracic wings are entirely wanting and the scutellum is very small.

The absence, or partial abortion, of the metawings, accompanied by an imperfect development of the hemelytra, occurs in several other Cryptocerate genera. For instance, all specimens of a large series of *Sphaerodema rusticum* collected at Murray Bridge, South Australia, have a stunted hemelytral membrane, and non-functional alae; these were taken from permanent water. Some individuals of the semi-aquatic *Matinus* have well-developed alae and hemelytra; others have a small hemelytral membrane and no metawings. A backswimmer recently described by me (Mjöberg's Swed. Sci. Exped. Aust.) belongs to the genus *Nychia*, but the wings and hemelytra are normal and well developed, unlike the condition described for the genus. Dr. Hungerford (1919, 178) mentions that the American *Plea striola* usually has aborted alae, but that apparently they are occasionally developed; the Neotropical Corixid genus *Palmacorixa* is said to have aborted metawings, but the same author (1919, p. 212 and 224) adds that they are sometimes present. Therefore, it seems that, in the case of the Cryptocerate bugs, the more or less constant degeneration of the wings in certain species cannot in itself be regarded as a character of much taxonomic value. Nevertheless, it is of interest in that it indicates a tendency to further specialization of insects already much modified for an aquatic habit.

According to our present knowledge of the Notonectinae, the species of four genera—*Martarega, Signoretiella, Nychia* and *Paranisops,* n.g., may have degenerate hemelytra and no metathoracic wings, but it has been shown that normal individuals occur in at least the two last-named genera.

An observation by Kirkaldy (1897, 398) indicates that, in some species of *Notonecta,* leucochroism may be associated with some slight abnormality of the hemelytra. This author writes "Melanochroism and leucochroism are more marked in this genus than in any other of the Rhynchota with which I am acquainted. . . . . A noteworthy fact is that, with the exception of *N. undulata, N. americana,* one or two *N. shooterii* and the luteous form of *N. maculata* (which, strictly speaking, is not leucochroic), all the luteous specimens, some forty or fifty, that I have seen, have unequal-lobed membranes. Dr. Bergroth kindly pointed out this peculiarity in *N. lutea.* I was at first inclined to regard it as a specific character, but found this view to be premature on meeting with luteous examples of *N. shooterii* . . . . some with ordinary, some with semi-developed lobes." Many, if not all, Notonectids are dorsally pale immediately after passing the final ecdysis, although pronounced pigmentation may be developed later. Immature coloration is not to be confused with permanent leucochroism.

Stal, Walker, Distant, Kirkaldy and other writers state that the antennae are four-segmentate in members of this subfamily. In *Anisops* and *Paranisops* there are but three true joints and, as noted by Champion (1901), this is also the case with *Buenoa.* Scott (1872) describes the antennae of *Nychia* as "four-jointed . . . . third minute." Kirkaldy (1897, 396) questions the presence of a tiny jointlet which Berg (1883) states is situated at the base of the third segment in *Notonecta* and *Signoretiella;* if this were regarded as a true segment, the antennae of these two genera would be five-jointed, consisting of scape, pedicel and three-jointed flagellum. In some genera this minute jointlet is moderately distinct, but in others it seems to be coalesced with the third segment; in either case it is of little importance, and has not been recognised in the following key. The antennae are irregular, and in general the scape is short, subglobular and somewhat bent, while the pedicel is conically-oval or irregular in outline, and is the stoutest of the antennal segments. (Pl. xlvii., fig. 1).

Key to Genera.

A. Antennae three-jointed.
- B. Anterior and intermediate legs short; posterior femora, tibiae and tarsi subequal in length. Eyes basally contiguous. .. .. *Nychia.*
- BB. Anterior and intermediate legs long; posterior femora, tibiae and tarsi not subequal in length. Eyes rarely basally contiguous.
  - C. Ventral keel extending to tip of abdomen. Anterior tibiae of male with a stridulatory comb on a basal spur. Ovipositor of female with a pair of elongate, sub-spatulate and strongly chitinized gonapophyses.
    - D. Anterior tarsi of male single-jointed. .. .. *Anisops.*
    - DD. Anterior tarsi of male two-jointed. .. .. *Buenoa.*
  - CC. Ventral keel not extending on to last abdominal segment. Anterior tibiae of male without stridulatory comb or basal spur. Ovipositor of female not so modified. .. .. *Paranisops.*

AA. Antennae four-jointed.
- E. Intermediate tarsi single-jointed. .. .. *Martarega.*

EE. Intermediate tarsi two-jointed.

F. Anterior angles of pronotum excavate. .. .. *Enithares.*

FF. Anterior angles of pronotum not excavate.

G. Eyes basally contiguous. .. .. *Signoretiella.*

GG. Eyes basally widely separated. .. .. *Notonecta.*

In the genera under section A the antennal flagellum consists of a single, more or less lunate segment, which is a little longer than the pedicel. In those under section AA the flagellum is bi-segmentate, with the proximal segment shorter than the pedicel in *Notonecta* and *Enithares*. The second segment of the flagellum is almost as long as the first in *Martarega*, slightly longer in *Enithares*, and much shorter than the first in *Notonecta* and *Signoretiella;* the aforementioned basal jointlet is included in the length of the first segment of the flagellum.

A basal contiguity of the eyes is not confined to *Nychia* and *Signoretiella*, for in *Anisops* (?) *breddini* Kirk., this character is conspicuous.

Five of the known genera, viz., *Notonecta, Anisops, Enithares, Nychia* and *Paranisops* must now be listed as occurring in Australia. Of the others, *Buenoa* is confined to North and South America, and Hawaii, *Martarega* and *Signoretiella* to South America.

PARANISOPS, n.gen.

Form slender. Eyes large and prominent. Notocephalon narrow, with the sides sub-parallel, slightly divergent. Rostrum four-jointed, the first and second segments subequal in length, the second shorter on sides; fourth a little longer than third, which is scarcely longer than the first. Labrum triangular, the sides concave, the subacute apex not reaching quite to middle of second rostral segment. Antennae three-segmentate, the single-jointed, lunate flagellum one-fourth longer than the pedicel. Scutellum large in melanochroic form, almost as long as the metathorax; very small in leucochroic form. Metathoracic wings present or absent. Hemelytra with or without claval and membranal sutures. Ventral keel of abdomen not extending on to last visible segment (anal plate); ovipositor of female short and weak. Tarsi of all legs two-jointed in both sexes; hind femora not extending to apex of hemelytra; inner edges of anterior and intermediate tibiae and tarsi closely set with short hairs, the outer edges with long spines.

Type, *P. inconstans*, n.sp.

The armature of the legs resembles that of *Anisops* and not of *Notonecta* and *Enithares*. In both *Anisops* and its near ally *Buenoa* the labrum is convexly-triangulate and extends to or beyond the end of the second rostral segment, the rostral joints are of different proportions and the ventral keel extends to the termination of the abdomen. Furthermore, pronounced pigmentation of the hemelytra is not developed in either of these genera. These characters, together with those given in the key, serve readily to distinguish *Paranisops*.

PARANISOPS INCONSTANS, n.sp. (Pl. xlvii., fig. 2).

♂. Head, including eyes, distinctly narrower than greatest width of pronotum. Notocephalon testaceous; basal third with an obsolete, median carina; beyond this is a median groove, not extending to vertex and having on each side a swelling; some long and silky, white hairs emanate from the posterior ends of these tumidities and from the inner margins of the eyes; vertex one and three-fourths times wider than the synthlipsis, which is three and one-half times in

the width of an eye. Pronotum shining, ochraceous anteriorly, merging into black posteriorly; width at humeral angles almost one and two-third times medial length; surface with some scattered punctures and a few silky hairs; a distinct, longitudinal median carina, not reaching to apex of anterior margin, which is well produced forwards between inner-posterior angles of eyes; lateral margins very oblique; posterior margin evenly convex, a little incrassate. Scutellum dull, black, two-thirds as long as pronotum; medial length one-half the basal width, which is five-sixths the greatest width of the pronotum, and equal to width of head including eyes. Metanotum and dorsum of abdomen black, polished. Hemelytra sub-nitid, closely and shallowly punctate and clothed with short pubescence; clavus blackish-brown; corium blackish-brown with an interrupted sub-hyaline stripe on anterior half; embolium ochraceous, almost as long as the corium; membrane brownish-black. Metawings largely sooty. Clypeus greenish-ochraceous suffused with blackish near apex; labrum brownish-black; third segment of rostrum suffused with brown, fourth segment black. Underside dull, brownish-black, paler on middle of sternum and near apex of abdomen. Anal plate brown, convex, not keeled. Anterior and intermediate femora ochraceous, marked with brown; tibiae and tarsi ochraceous, their outer surfaces with a broad, brown stripe. Posterior legs ochraceous, the femora with two longitudinal brown stripes, and tibiae and tarsi brown on outer edges. Anterior tibiae about one-fourth longer than tarsi and intermediate tibiae one-third longer than tarsi. Anterior and intermediate tarsi each with the first joint two-thirds longer than second; claws subequal in length, curved, acute and tipped with black, the longer of each pair more than half as long as the last segment of its tarsus. Posterior femora a little longer than tibiae, which are more than one-third longer than tarsi; first tarsal segment about twice as long as second. Length, 7 mm.; width, 2.1 mm.

Hab.—New South Wales: Berowra Creek (type loc., Nicholson), Epping (Gallard). Type male in South Australian Museum.

The sub-hyaline stripe of the corium is more extensive in the example figured than in the holotype.

PARANISOPS INCONSTANS var. LUTEA, n. var. (Pl. xlviii., fig. 3).

Differs from the perfect variety in the following characters:—Form of slightly different shape, narrowed anteriorly and widest across metathorax. Head, including eyes, not much narrower than pronotum. Notocephalon testaceous. Pronotum sub-hyaline, suffused with testaceous anteriorly; lateral margins not very oblique. Scutellum luteous, very small, about one-fifth as long as pronotum. Hemelytra sub-hyaline excepting for an apical patch of brown pigment and a faint brownish marking near embolium; without claval or membranal suture, and scarcely overlapping posteriorly; embolium long. Abdomen dorsally luteous, marked with brownish along sutures. Hairs of underside black. Sternum ochraceous, and abdomen ochraceous, in parts blackish. Length, ♂ 6.9 mm.; width, 2 mm. ♀ length, 7 mm.; width, 2.25 mm.

Hab.—New South Wales: Epping (type loc.) and Berowra Creek (Nicholson). Type male in South Australian Museum.

The above descriptions are made from specimens preserved in alcohol; a hemelytron of both forms is figured as flattened on a plane surface.

There is no marked dimorphism of the sexes. The anterior femora of the

male are slightly stouter, the eyes a little more prominent, the anal plate narrower and the form rather more slender than in the female.

It has been shown that in some other Cryptocerates the same species may, more or less constantly, produce a form with incompletely developed wings, as well as a form with perfect wings, and also that, in the Notonectinae, such deterioration may be associated with leucochroism. Admittedly, modification is extreme in the luteous examples described above, and involves the scutellum and, to some extent, the pronotum also. Nevertheless, the two varieties are specifically connected by the structure of the legs, shape of the notocephalon, etc.,—in fact, the pale form, which is obviously degenerate, can only be separated by structural differences which may be ascribed to degeneration. In some of the semi-aquatic Gymnocerata the differences between the apterous and macropterous forms of the species are very marked.

It will be noted that the two forms were taken in the same localities. An investigation of the life-cycle of this species may show that both varieties occur in the same brood. Mr. Nicholson supplies the following note concerning the situation in which the bugs were taken: "The backswimmer was taken in typical creeks of the Hawkesbury Sandstone country which surrounds Sydney. These creeks often cease to run for considerable periods during the summer, but water always remains in deep, scattered 'potholes' in the sandstone bed of the creeks. These 'potholes' usually contain a considerable number of insects and crustacea of various kinds."

Some characters mentioned by Kirkaldy (1904, 114) in his description of *Anisops endymion* suggest that this species possibly belongs to *Paranisops*. The pronotum is described as being much more distorted between the eyes than in other species, while the hemelytra are apparently pigmented, a condition, as previously mentioned, unusual for *Anisops*. In *P. inconstans*, however, the tarsal segments are of different proportions, the synthlipsis is much narrower, the size smaller and the form more slender than in Kirkaldy's species. *A. endymion* was described from a single female from the Swan River, and the type reposes in the Perth Museum, Scotland.

Family SALDIDAE.

SALDA Fabricius, 1803.

Type, *Acanthia littoralis* Linnaeus.

SALDA NICHOLSONI, n.sp. (Pl. xlviii., fig. 4.)

♂. Form somewhat narrowly sub-oval. Notocephalon black, shining, with a yellow spot near middle of length of inner margin of each eye and another on each side near apex of head; very finely punctate, and clothed with short, forwardly-directed yellow pubescence and a few long, stiff, black hairs; as long as medial length of pronotum and with a distinct neck. Ocelli yellow, almost contiguous. Eyes very prominent, their inner margins markedly converging apically. Face and labrum ochraceous, in parts suffused with brown. Rostrum testaceous on proximal half, the remainder dark brown; reaching almost to middle of posterior coxae. Throat black. Antennae black, with proximal half of basal segment brown; long and slender, rather thickly clothed with short, stiff pubescence intermixed with a few longer hairs; second segment two and one-fifth times as long as the first and one and three-fifths times as long as third; fourth segment slightly thickened, its length (including a minute basal jointlet) one and one-tenth times that of third. Pronotum black, with a yellow dash near

each humeral angle; surface shining, very finely punctate, and clothed with golden pubescence a little longer than that of head; on callus intermixed with a few longer, black hairs; width at anterior margin much less, and width at humeral angles much greater, than width of head including eyes; hinder margin broadly emarginate and lateral margins distinctly sinuate; callus large, convex, occupying three-fourths of the medial length of pronotum, extending almost to lateral margins and with a small fovea, placed slightly in advance of the centre of the disc. Scutellum black, finely punctate and clothed with backwardly-directed golden pubescence, excepting near anterior angles; one-fifth wider than long, with a distinct impression, situated at about middle of disc; apex tumid. Hemelytra reaching well beyond termination of abdomen; in parts sub-nitid, the remainder of a velvety appearance; clothed with golden pubescence, sparse on sub-nitid areas. Clavus black, with a median dull, yellow streak opposite apex of scutellum. Corium black, with an obscure whitish streak near anterior angle, a spot of the same colour near outer margin at the first third of the length, a dull, yellow line parallel to posterior end of outer margin and a yellow spot near middle of posterior margin. Embolium black, with a greyish spot near middle of inner edge and another larger marking near apex; outer margin yellow, incrassate. Membrane with four distinct areoles; veins black; each areole with two large, pale yellowish, sub-hyaline areas, delineated with sooty-brown. Underside black, shining, clothed with golden pubescence, which is longest and thickest laterally. Legs and ambulacra largely ochraceous; femora and tibiae marked with brown, the latter almost black at apex; spines and tarsi brownish-black. Anterior and intermediate femora longer than tibiae. Posterior tibiae very long, a little curved, one-half as long again as femora and three times as long as tarsi; third and fourth segments of tarsi equal in length. Length, 4.3 mm.; width, 1.9 mm. to 2 mm.

♀. Form stouter, distinctly wider across middle of hemelytra. Hemelytra extending well beyond termination of abdomen. Underside of abdomen sordid ochraceous, infuscated with black; terminal ventral segment produced, angularly-rounded at apex; ovipositor prominent (*cf.* Pl. xlviii., fig. 4, c and d). Length, 5 mm.; width, 2.2 mm.

Hab.—New South Wales: Wentworth Falls, 2844 ft. (Nicholson). Type male and allotype female, in South Australian Museum.

A yellow spot is sometimes present at postero-lateral angles of underside of head; the hemelytral membrane in some specimens is mostly black, with the pale areas reduced or absent. In certain respects this graceful species appears to be intermediate between *Teloleuca* Reuter, and *Salda* as diagnosed by Reuter (1912).

The insects were found "at the base of a waterfall, on a small rock which was constantly subjected to fairly heavy spray. They moved freely and rapidly over the surface of the rock in spite of the spray."

Three other species of the family—*S. reuteriella* Kirk., *S. cygni* Kirk., and *S. salina* Bergroth—have been previously recorded from Australia; the first two are from Western Australia, the last from salt-water pools, Admiralty Gulf, N.W. Australia. Of these, *S. reuteriella* most nearly approaches *S. nicholsoni*, which may be separated by the different proportions of the antennal and tarsal segments, and by the longer rostrum.

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EXPLANATION OF PLATES XLVII.-XLVIII.

Plate xlvii.

1. Antennae of Notonectinae. *a*, *Nychia* (scape not shown); *b*, *Paranisops*; *c*, *Anisops*; *d*, *Enithares*; *e*, *Notonecta*. (All enlarged 50 diams.).

2. *Paranisops inconstans*, male. *a*, head and thorax; *b*, hemelytron; *c* and *d*, anterior and intermediate legs.

Plate xlviii.

3. *Paranisops inconstans* var. *lutea*, male and female. *a*, head and thorax of male; *b*, hemelytron.

4. *Salda nicholsoni*. *a* and *b*, antenna and posterior leg of male; *c* and *d*, ventral view of abdomen of male and female.

ELEVEN NEW SPECIES OF *AVICULOPECTEN* FROM CARBONIFEROUS ROCKS, MYALL LAKES, N.S.W.

By John Mitchell, late Principal of the Newcastle Technical College and School of Mines, N.S.W.

(Plates xlix.-lii.)

[Read 24th September, 1924.]

The eleven new species of *Aviculopecten* described and figured below are divisible into three or more distinct specific groups, which appear in recently discovered fossiliferous beds on the shores of one of the Myall lakes for the first time in New South Wales. Two of the most characteristic of these groups include: (1) *Aviculopecten leggei, A. andrewsi, A. sparteus* and *A. perobliquatus;* (2) *A. argutus, A. flexicostatus* and *A. articulosus.* From Carboniferous rocks of the Burindi and Kuttung Series, no Aviculopecten closely allied to the species included in either of these two groups has been recorded. This, together with the advanced structural features displayed by the fossils in question, affords reasonable grounds for assuming that the geologic horizon of the Myall lake beds, from which the fossils now being dealt with were secured, is more recent than either of these two series. The Myall beds, therefore, may belong to the upper part of the Lower Carboniferous, or to the lower portion of the Middle Carboniferous system. On the evidence presented by the fossils these beds have yielded, it seems safe to place them as above. The following are some of the genera obtained: Brachiopoda: *Productus, Chonetes, Spirifer* (many new species); Lamellibranchiata: *Edmondia, Streblopteria* (?), *Aviculopecten* (described in this paper); Trilobita: *Cordania gardneri.*

All the Aviculopectens described in the present paper are from the beds referred to above outcropping on Brambles farm, Parish of Eurenderee, County of Gloucester, New South Wales. These beds have been tilted by an intrusion of igneous rock of diabasic appearance.

The species included in group (2) referred to above, have a closer general resemblance to the Viséan Aviculopectens described by the late Prof. de Koninck (Ann. Mus. Roy. d'Hist. Nat. Belg., t. xi.) than to any others it has been found possible to compare them with.

Aviculopecten leggei, n.sp. (Pl. xlix., fig. 1; Pl. l., fig. 12.)

Whole shell plano-convex, inequilateral, triangular, or fan-like. Left valve strongly convex near the umbo, and from there slopes steeply to the ventral margin. Radials consist of about twelve primaries, an equal number of secondary interpolations which begin near the umbo; towards the ventral margin a pair of

tertiaries is introduced, one on each side of a secondary; all are triangular in section and separated by concave spaces; umbonal ridges prominent and meet the cardinal margin at angles of 30°; beak prominent, pointed and slightly incurved. Anterior auricle slightly convex, triangular, bears about six or seven radials; byssal sinus distinct. Hinge plate straight and shows three or more ligamental furrows. Posterior auricle missing. Neither on the body or auricle of this valve are concentric striae visible. A fragment of the right valve is present in apposition with the left, partly joined by the hinge; it is practically flat, smaller than the left one; radials dichotomous and not prominent. Dimensions of the left valve: length, 32.0; width, 25.0; depth, 4.0 mm.

This species, with *A. sparteus*, *A. perobliquatus* and *A. andrewsi*, forms a distinct and closely allied group, which as far as the present evidence shows, appears in these Myall lake beds for the first time in New South Wales, and seems not to have persisted through any great length of geologic time.

Dedicated to Mr. H. Legge of Legge's Camp, Myall lakes, N.S.W., who gave valuable help to the writer when collecting the fossils described in this paper.

AVICULOPECTEN FUSIFORMIS, n.sp. (Pl. xlix., fig. 2.)

Left valve fusiform, convex, medially ridged. Radials increased chiefly by interpolation, prominent, straight with a slight and gradually increasing curve towards the lateral margins from the medial longitudinal line; concentric striae very fine and numerous, but indistinct on testless valves; umbo prominent, pointed and reaches the cardinal margin. Anterior umbonal ridge prominent, falls steeply to the auricle and is short; posterior ridge long and ill-defined; with the cardinal line they form angles of 45° and 60° respectively. Both auricles are nearly perfect, the posterior one being much the larger; they are flat, triangular and crowded with almost microscopic transverse striae; the anterior one meets the cardinal line at an angle greater than a right angle, and its lateral margin is oblique; the latero-cardinal angle of the posterior one is about a right angle and its lateral margin mildly sinuate. Dimensions of a small left valve: length, 21.0; width, 31.0 mm.

Right valve unknown.

The species forms quite a singular type of the genus *Aviculopecten* as far as known Australian species are concerned. The distinguishing features of the species are (1) fusiform outline, (2) shoulder-like aspect of the anterior umbonal ridge, (3) almost microscopic fineness of the striae on the auricles, (4) pronounced dorso-ventral ridge, (5) disparity of the auricles in size.

AVICULOPECTEN PYRIFORMIS, n.sp. (Pl. xlix., fig. 3.)

Left valve pyriform, strongly convex, subequilateral, dorso-laterally subridged, slopes more rapidly to the anterior lateral margin than to the posterior one. Radials numerous, slender, slightly interrupted in their course at one or more of the lati-concentric growth lines, consist of three orders. Lateral and ventral margins together form about two-thirds of an ellipse. Beak prominent, pointed and reaches the cardinal margin; umbonal ridges prominent and make with the cardinal margin angles of about 45°. Anterior auricle missing from the type specimen, but in another appears to be triangular with an oblique outer margin; posterior auricle larger than the anterior one, triangular, radials not visible, but traces of fine cross striae are plainly discernible, flat, lateral margin mildly sinuous. Hinge plate bears several ligamental furrows. Right valve un-

known. Cardinal margin about half as long as the length of the valve. On the body of the valve concentric striae are numerous. Dimensions of the type valve: Length, 50.0; width, 63.0 mm.

This species has some resemblance to the species just described (*A. fusiformis*), to which it is without doubt closely related; in dimensions the two forms differ widely and on this account they have been separated; but it may be pointed out also that on the hinge plate of *A. pyriformis* several ligamental furrows are distinctly visible; none such have yet been noticed on the hinge plate of *A. fusiformis*.

AVICULOPECTEN ANDREWSI, n.sp. (Pl. xlix., figs. 4-6.)

Shell of moderate size, valves very unequal.

Left valve very transverse, both posteriorly and anteriorly, strongly convex. Radials about twenty-eight in number, moderately prominent, ridged, apparently simple, and separated by concave spaces about twice as wide as themselves; concentric striae numerous, and on crossing the radials form distinct nodes. Beak prominent, pointed, and reaches the cardinal margin. Auricles over moderate size, wing-like, the anterior one smaller than the posterior and traversed by four or more indistinct oblique radials and numerous concentric striae, convex, clearly separated from the body, its outer border sinuate; posterior one depressed, of similar shape to the other, definitely separated from the body. Anterior umbonal ridge prominent, strongly curved or bow-shaped; posterior one long and less definite. Cardinal margin and hinge much shorter than the greatest length of the valve.

Right valve much shorter than the left one, very mildly convex; ribs numerous, indistinct, of two orders at least; concentric striae numerous but indistinct, ventral margin evenly rounded; auricles similar in shape to those of the other valve, but less definite, their radials and concentric striae similar in number and character to those of the opposing valve, but only faintly defined; anterior ear mildly convex, definitely separated from the body of the valve; lateral margin sinuous; posterior ear depressed, larger than the anterior one, radials and striae faintly defined; umbonal ridges low; beak not prominent. Dimensions of left valve: Length, 55.0; width, 45.0; hinge, 35.0 mm. Dimensions of right valve: Length, 30.0; width, 30.0 mm.

This is a well-marked species. Dedicated to E. C. Andrews, Esq., B.A., Government Geologist of New South Wales.

AVICULOPECTEN SPARTEUS, n.sp. (Pl. l., fig. 7; Pl. lii., fig. 23.)

Left valve obliquely transverse, inequilateral, strongly convex, outline like that of a yard broom which has been in use for some time, laterally produced anteriorly and posteriorly; ribs prominent, increased by several interpolations, strongly directed towards the lateral margins, bear traces of nodes; concentrically sub-wrinkled. Anterior umbonal ridge prominent and subcurved, posterior one indefinite; umbo absent, but was evidently prominent; auricles absent? What is taken to be the right valve of the species is sub-equilateral, very mildly convex, much smaller than the left valve; ribs faint, apparently of two orders, subconcentrically wrinkled. Umbonal ridges moderately prominent, enclosing an angle of about 105°, anterior one slightly curved; ventral margin evenly rounded. Auricles triangular, of about equal size, posterior one flat, shows faint traces of very fine cross striae, but no radials visible, meets the cardinal line at nearly

a right angle; anterior ear damaged, very mildly convex, clearly separated by a sulcus from the body. Cardinal margin approximately half as long as the length of the valve. Hinge plate narrow, exhibits one ligamental furrow and a small resiliifer. Beak prominent and barely reaches the cardinal margin. Dimensions: Right valve, length, 30.0; width, 20.0 mm.; left valve, length, 40.0; width, 28 mm.

If the right valve here assumed to belong to this species, proves really to be so, it will become a question whether it should be placed in the genus *Deltopecten* Etheridge and Dun; but when determining this question it must not be overlooked that some American palaeontologists have so amended McCoy's original description of the genus *Aviculopecten* as to include the presence of a resiliifer (Grabau and Shimer, North Am. Ind. Foss., 1909, Vol. I).

This species and *perobliquatus* bear some resemblance to each other, but are easily distinguished one from the other.

Aviculopecten perobliquatus, n.sp. (Pl. l., figs. 8, 9.)

Whole shell very oblique, subplanoconvex, very inequilateral. Left valve larger than the right, strongly convex, obliquely subtrapezoidal; ribs numerous, apparently of three orders, separated by narrow interspaces; concentric striae numerous, but indistinct on the testless specimens, which alone are available, but show an imbricate pattern. Anterior auricle absent; posterior one imperfect, large, triangular, radials and concentric striae indistinct; beak absent, but appears to have been prominent. A medial umbonal ridge obliquely traverses the medial part of the valve. Right valve only mildly convex, oblique, much smaller than the left, bears several ill-defined concentric folds, ribs and concentric striae faint, the former seem to be simple. Anterior auricle imperfect, small, clearly separated from the body by the byssal sinus; outer margin rounded; posterior ear large, depressed, and faintly radiated. Umbonal ridges prominent; beak prominent, reaches the cardinal margin, which is much shorter than the length of the shell. Some ribs of the right valve as they approach the latero-ventral margin, assume a zig-zag course. This feature is present in several of the species of *Aviculopecten* from the Myall Lakes, and is one that has not been observed by me in any species of the genus from elsewhere. The valves, described above, are conjoined by the hinges, but are widely agape ventrally. Dimensions: Left valve, length, 47.0; width, 30.0 mm.; right valve, length, 35.0; width, 25.0 mm. Length of hinge, 22.0 mm. The umbonal ridges of the right valve diverge from the beak at angles of about 30° and 45° and include an angle 105° approximately.

This is one of the most oblique of Aviculopectens and in that respect surpasses all others which have come under my notice.

Aviculopecten argutus, n.sp. (Pl. l., figs. 10 and 11.)

Outline of the shell suborbicular, mildly biconvex and of moderate size. Left valve mildly and evenly convex. Radials numerous, consist of primaries and an interpolation of a secondary between each pair of primaries, except in one case where two secondaries are interpolated between a pair of primaries, concentric striae numerous and form nodules on the radials; beak and auricles absent. Right valve mildly convex, smaller than the left, almost smooth for the radials are only faintly visible on testless valves. Beak slightly defective, but

prominent and pointed. Auricles only partly preserved; the anterior one clearly separated from the body by the byssal groove; umbonal ridges moderately distinct. Dimensions of the right valve: Length, 37.0; width, 35.0 mm. approx.

The distinctive features of the species are (1) the single interpolation between each pair of primaries; (2) stoutness of the primaries; (3) slight convexity of the right valve and its relative smoothness; (4) flexuring of the radials from their normal course at one or more of the laticoncentric striae, in this respect resembling *A. flexicostatus*, also described in the present paper.

The two valves described above are in apposition.

AVICULOPECTEN FLEXICOSTATUS, n.sp. (Pl. l., figs. 13-16; Pl. lii., figs. 21 and 22.)

Left valve orbicular, mildly and evenly convex, slightly inequilateral. Radials very numerous, of three orders, distinct, but not prominent; concentric striae very numerous, fine, regularly spaced, and produce with the radials a neat cancellate pattern. Umbo depressed, pointed, barely reaching the cardinal margin. Anterior umbonal ridge short, falls vertically to the ear, and makes with the cardinal line an angle of about 45°. Posterior ridge less prominent and longer than the other; makes with the cardinal line an angle of about 30°. Ears of nearly equal size, triangular, bear six radials, and crowded concentric striae. Cardinal margin and hinge plate straight, less than half as long as the greatest length of the shell. Right valve, or what is assumed to be such, less convex than the other, nearly flat towards the ventral margin, but in other respects resembles the left valve. Dimensions of left valves: Length, 50.0, 40.0, 37.0; width, 46.0, 36.0, 34.0 mm. The measurements are approximate in each case.

This *Aviculopecten* bears a general resemblance to *A. caelatus* McCoy, and also to *A. plagiostomus* de Koninck, both of which are found in the Carboniferous Limestone of Visé (étage III.) of Belgium.

AVICULOPECTEN PINCOMBEI, n.sp. (Pl. li., fig. 18; Pl. lii., figs. 19, 20.)

Shell moderately large. Left valve convex, tumid near the umbo, subdepressed adjacent to the postero-lateral margin; ribs thirty to thirty-three, according to size, simple except for an odd interpolation in some specimens, mildly ridged, and separated from each other by wide slightly concave spaces. Concentric striae very numerous, distinct, produce mild echination or imbrication of the ribs as these are crossed by them. The anterior and ventral margins are neatly rounded, the latter one forming a semicircle; posterior margin from the ear to the ventral one straight and oblique; umbo prominent, blunt, and just reaches to the cardinal border. Anterior auricle triangular, very mildly convex, emarginate at its junction with the body, rounded at the cardinal angle, bears some four or five gently oblique indistinct radials; and numerous fine concentric striae; byssal sinus distinct. Posterior auricle much larger than the anterior one, subwing-shaped, openly emarginate, ornamentation similar to that of the anterior one, rounded at the cardinal angle, outer margin mildly sinuate, indefinitely separated from the body. Anterior umbonal ridge prominent and makes an angle of 45° with the cardinal border; posterior umbonal ridge indefinite.

Cardinal border and hinge plate straight, more than half as long as the length of the valve. A specimen with the valves in apposition shows the hinge plates slightly agape, indicating the presence of a strong ligament.

An indifferently preserved cast of the two valves of this shell in apposition

shows the right valve to be very mildly convex in the vicinity of the large muscular area, and towards the lateral and ventral margins to be slightly concave; ribs indistinct, apparently simple and secondary, and on the muscular area they are not visible. Outline of the two valves conjoined is that of a segment about equal to five-sixths of a complete circle. Dimensions of left valves: Length, 80.0, 60.0, 60.0; width, 65.0, 55.0, 55.0 mm; depth, 15.0 mm.

The description above was made from testless specimens, except in the case of one left valve. This *Aviculopecten* is quite a conspicuous one. In some features it resembles *A. granosus* J. de C. Sowerby, from the Middle Carboniferous Limestone of Ireland and Belgium, but is specifically far removed from it.

Dedicated to T. H. Pincombe, Esq., B.A., who, with Mrs. Pincombe, was associated with the writer when the specimens here described were collected.

AVICULOPECTEN PLICATILIS, n.sp. (Pl. lii., fig. 25.)

Right valve mildly convex, sides subparallel, ventral margin rounded; radials indistinct, dichotomous, almost invisible towards the posterior margin; beak subprominent; anterior auricle triangular, clearly separated from the body of the shell by the byssal sinus; posterior auricle aliform, pointed, very indefinitely separated from the body; both auricles bear fine curved concentric striae, but are otherwise smooth; cardinal margin long and straight; hinge plate long, narrow and bears one distinct ligamental furrow; the cardinal margin and hinge plate are much longer than the shell. Left valve unknown. Dimensions of the right valve: Length, 15; width, 16 mm.

This *Aviculopecten* resembles in outline and ornamentation, some Pterineas (*P. brisa* for instance). Among Australian Aviculopectens, as far as I am aware, it is singular.

It may be noted further that this form is very near to *Aviculopecten* (*Pecten*) *megalotis* McCoy. The ornamentation of the two is alike as far as their radials and concentric striae are concerned; but the local form has a more pointed and aliform posterior auricle and a larger anterior auricle than are possessed by the Irish form, and is also much larger.

EXPLANATION OF PLATES XLIX.-LII.

Plate xlix.

1. *Aviculopecten leggei* Mitchell. A left valve minus the posterior auricle and hinge plate. Portion of the right valve is attached to it by the hinge. On the anterior part of the hinge plate of the latter, two or three ligamental furrows are visible (x 2 nearly).

2. *Aviculopecten fusiformis* Mitchell. A nearly perfect left valve (x 2).

3. *Aviculopecten pyriformis* Mitchell. A large left valve, minus the anterior ear, and having the postero-lateral margin slightly defective (slightly enlarged).

4. *Aviculopecten andrewsi* Mitchell, showing the two valves conjoined, but widely gaping ventrally (x 1½).

5. Left valve of the above (x 1½). An almost perfect specimen exhibiting the ornamentation clearly.

6. A photo of a right valve, taken under a strong oblique light to show up the faint radials (slightly enlarged).

Plate l.

7. *Aviculopecten sparteus* Mitchell. A left valve of which the figure is a good one; the auricles and beak are absent; the nodes on the radials are clearly visible (x 2 approx.).

8. *Aviculopecten perobliquatus* Mitchell. An almost perfect right valve (x 1.4).

9. The left valve of the above, with which it is in apposition. The whole of the anterior auricle, part of the posterior auricle and part of the ventral margin are missing (x 1.6).

10. *Aviculopecten argutus* Mitchell. A good photo of a defective left valve (slightly enlarged).

11. The right valve of the above with which it is in apposition; both auricles and the anterior lateral margin are defective (x 1.6).

12. The right valve of *A. leggei.* It is joined by the hinge to the left valve (Pl. xlix., fig. 1); (x 2 nearly).

Plate li.

13, 14. *Aviculopecten flexicostatus* Mitchell. Two photos from an intaglio (cover) of a left valve, and wrongly represent the radials, in part at least, to be dichotomous. This happens because in such a specimen the interspaces of the radials, are in relief instead of the radials themselves. The photos otherwise show the external ornamentation of an immature valve very distinctly (x 2.3 and 1¾ respectively).

15, 16. Left valves of the same species, showing the radials correctly; 15 represents a mature specimen (x 1.6 and 2 respectively).

17. *Aviculopecten articulosus* Mitchell. A view of the valves in apposition, from the left side; about half of the left is broken away and exposes the right one in part. The peculiar jointing of the radials of the left valve at the laticoncentric growth lines is clearly visible.

18. *Aviculopecten pincombei* Mitchell. Side view of a cover of a left valve (nat. size).

Plate lii.

19. A very fine left valve of the same, partly testiferous (x 8/7).

20. A cast of a right valve in apposition with its left valve; the hinge plates are shown agape, and the muscular area subcentral. The circular object towards the posterior margin is a foreign body which pierces both valves (x 1.3).

21. What is assumed to be the right valve of *A. flexicostatus.* The margins are defective (x 2).

22. A fragment of the cover of a left valve of *A. flexicostatus,* clearly showing the ornamentation and the flexuring of the radials (x 2 approx.).

23. The right valve of *A. sparteus.*

24. A small left valve of *A. perobliquatus* (enlarged).

25. A right valve of *Aviculopecten plicatilis* Mitchell showing the features of a testless specimen fairly well (x 1¾).

AN ECOLOGICAL STUDY OF THE FLORA OF MOUNT WILSON.

Part i. The Vegetation of the Basalt.

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(Plates lvii.-lx.; and five Text-figures.)

[Read 26th November, 1924.]

Contents.

Introduction.

During the last decade the study of Plant Ecology has developed with great rapidity in Britain, on the Continent, and in America; and from time to time the record has been enriched by a contribution from some far-off field. But little Ecology, however, has been carried out so far in New South Wales, despite the fact that innumerable fascinating and important problems await solution.

It was, therefore, with the view of stimulating the advance of ecological work in this country that the Sydney University Botanical Society in 1923 initiated a study of the vegetation of Mount Wilson. The Society has organised expeditions for field observations from time to time, and the present paper embodies some of the results obtained. These results are largely of the nature of primary survey, which has been carried out for the purpose of studying the relationships and distribution of the various plant communities, and also to lay a foundation for future intensive investigation.

The authors desire to express their indebtedness to Professor Lawson for suggestions in regard to the institution of the work, and to those members of the Botanical Society who gave valuable assistance in collecting and charting in the field.

Hamilton (1899) has already published a list of the plants occurring in the Mt. Wilson area, but the present paper will deal with the structure and physiognomy of the associations on the basalt rather than with the enumeration of the species.

General Features of the Australian Flora.

The flora of Australia possesses many interesting and peculiar features, and early systematists considered that it belonged to a different geological period of the earth's history from that in which existing plants of other lands have been produced, or that it represents a separate creative effort, or that the influence exerted by the Australian climate in the past differed from that of the climate on the floras of other lands.

Hooker (1860) in his essay on the Australian Flora, points out that it does not differ fundamentally from other floras and, "whether viewed under the aspect of its morphology and structure, as exhibited by its natural classification, or its numerical proportions, or geographical distribution, it presents essentially the same primary features as do those of the other great continents."

The outstanding peculiarities of the Australian flora are:

(1) Its high percentage of endemism, as "it contains more genera and species peculiar to its own area and fewer plants belonging to other parts of the world, than any other country of equal extent. About two-fifths of the genera and upwards of seven-eighths of its species are entirely confined to Australia." But this high endemism is also a feature of other world floras, for isolation from neighbouring land masses tends to induce endemism in plastic forms. Long isolation from the surrounding lands probably explains the high percentage of endemism in Australia.

(2) The peculiar habit and physiognomy of many of its constituents, e.g., the species of *Eucalyptus* with pendulous leaves, the Casuarinas with switch-like branches, the Xanthorrhoeas or Grass-trees, the phyllodineous Acacias, the Banksias with their cone-like inflorescences, *Telopea, Doryanthes excelsa,* the conspicuous and characteristic Gymnosperms (species of *Callitris* and *Macrozamia*), the large variety of flowering trees, the dull greyish-green of the Eucalyptus Forest, the scraggy foliage of the Proteaceae, and many of the Leguminosae and Goodeniaceae of the xerophytic habitats.

(3) The many interesting structural peculiarities, e.g., the calyptra of the flowers of *Eucalyptus,* the irritable gynostemium of *Stylidium,* the hard woody seeds and fruits of many Proteaceae and Leguminosae, the irritable labellum of species of *Pterostylis,* the deciduous character and large chlorophyll-content of the bark of species of *Eucalyptus* and *Angophora,* the stomata of the Proteaceae, the phyllodes of *Acacia,* the fleshy peduncle of *Exocarpus* and the pitchers of *Cephalotus,* etc.

But features of this nature are not important enough to stamp the Australian Flora as belonging to a different geological epoch from that of other floras, or as being fundamentally different. This is clearly borne out by Hooker's observations, viz. (1) that the relative proportions of Dicotyledons to Monocotyledons, of genera to orders, of species to genera, are the same as in other floras of equal extent; (2) that the Thalamiflorae, Calyciflorae, Corolliflorae, etc., are in the same relative proportions as in other floras; (3) that the proportion of Gymnosperms to other Dicotyledons is about the same; (4) that only two orders (with three genera and few species) are peculiarly Australian,

viz., the *Brunoniaceae* and the *Tremandraceae*; (5) that the remaining Australian orders are found in other countries, and some are amongst the most widely distributed over the globe (e.g., *Compositae, Leguminosae, Ranunculaceae*); (6) that the families *Goodeniaceae, Candolleaceae, Casuarinaceae,* which are abundant in Australia and rare elsewhere, have a close affinity with the *Campanulaceae, Lobeliaceae,* and *Myricaceae,* which are widely distributed over the globe; (7) that most of the Australian orders and genera which are also found in other countries around Australia have their maximum development in points approximating in geographical position towards these neighbouring countries, e.g., the Malayan element in north-eastern, the South African in south-western Australia; (8) that the peculiarities of the Australian Flora do not disturb the natural system derived from the study of the flora of the earth, apart from that of Australia; (9) that the changes in vegetation in passing from tropics to colder latitudes, from dry to moist regions, from lowlands to mountains, are in every respect analogous to those which occur in other parts of the earth; and (10) that the Australian families and genera fall into their places in the natural system well enough, though that system was developed before Australia was known botanically.

Origin of the Flora of Mt. Wilson.

The Flora of New South Wales is probably the most interesting of the whole continent on account of the complexity of its composition. It not only contains a dominant endemic element, represented principally by highly xerophilous forms, but also a strong representation of the Polynesian-Malayan Flora, and of the Fuegian or Antarctic types. Probably also in the western parts of the State an African element is present. The distribution and constitution of these exotic floras will be described in later papers, but for the present the writers are concerned mainly with the structure and inter-relationship of the Malayan and autochthonous floras as they occur in the Mount Wilson region.

The Polynesian-Malayan or the Indo-Malayan element is represented in Eastern Australia by a typical Rain-Forest, which is best developed in eastern Queensland and New South Wales. Representatives of this flora occur at the present time in Victoria and Tasmania, but there is a distinct decrease in the richness of this Malayan Rain-Forest on passing from north to south, which fact may be attributed to the increasing severity of the climate as the southern parts of the continent are approached, and also to the greater distance from the original centre of distribution to the northward. The Malayan element probably reached the Australian continent while it was still connected to the New Guinea region, as its types (if we except the purely shore vegetation such as seaweeds, mangroves, and dune vegetation) produce seeds and spores which are not specially adapted for dissemination through the agency of water. The seeds and fruits are not even particularly efficient for wind dissemination, although many of the Pteridophytic and Bryophytic forms characteristic of the Rain-Forest may have reached Australia through the agency of wind, over an intervening belt of sea; but it is more probable that much of this fern flora migrated along with the larger elements of the Rain-Forest over a land bridge.

Angiosperm remains have not been found in the Cretaceous strata of New South Wales, but groves of Coniferous tree stumps have been found in section in the Desert Sandstone Formation (Cretaceous) of the De Grey Ranges (Süssmilch, 1922, 184), thus showing that preservation was possible. These facts

might indicate that Angiosperms did not occur in New South Wales during Cretaceous times. Fossil leaves of a considerable number of genera of Dicotyledons have been found in freshwater beds in Queensland; but there is some doubt whether these beds are Cretaceous (Süssmilch, 1922, 184); with one possible exception (Walkom, 1919) they are probably of Tertiary age. If this view be correct, then it is probable that Australia was connected with the land to the northward (New Guinea Region) into the Tertiary period, and that the Indo-Malayan Angiosperm Flora reached this continent in the early Tertiary.

Fossil prints and leaves have been found in Tertiary strata, especially in the upper beds; and silicified wood has been obtained from the lower beds. The fossil prints most commonly found are *Plesiocapparis*, *Spondylostrobus*, and *Penteune*, while fossil Dicotyledonous leaves have been obtained from Gulgong and Forest Reefs beds (Süssmilch, 1922, 202). These leaves are stated to belong to such genera as *Quercus*, *Fagus*, *Cinnamomum*, *Laurus*, *Magnolia*, *Bombax*, *Pittosporum*, *Banksia*, *Eucalyptus* and *Grevillea*, which are practically all constituents of the present day sub-tropical Rain-Forest of Eastern Australia, and which is chiefly Malayan in origin. The autochthonous types, *Eucalyptus*, *Banksia* and *Grevillea*, which are typical representatives of the xerophilous flora of the sandstone, are here found in association with the Malayan forms. If the identification be correct—and it must be conceded that the evidence of leaf impressions is not too reliable—we have endemic and Malayan forms occurring contemporaneously as the oldest known Angiosperm flora of New South Wales, very much as they exist in close proximity in the richer soil regions of the State at the present day.

In the upper Tertiary period this Rain-Forest apparently had a much more extensive distribution, as Tertiary fossil plants very similar to the living Rain-Forest types have been found at Orange, in the far western districts of New South Wales and Queensland (Horn Expedition, Tate and Watt, 1896), and on the high tablelands which have now a cold dry climate. The present range, especially from east to west, is comparatively restricted, but from the fossil evidence it is highly probable that the physiography of the country and the climate were such as to support a more luxuriant, almost tropical flora. Moreover, the animal life of the Tertiary period throws interesting light upon the plant life (Süssmilch, 1922, 213). The Tertiary vertebrates, as indicated by the fossils, were larger than any living to-day, and great numbers inhabited what are at present the more arid regions of the State. They were not adapted for travelling long distances in search of food, and it is extremely probable that a luxuriant flora existed in the extreme western districts of the State, and this implies abundant rainfall and high temperature, in short, a tropical climate.

The present tablelands or plateau regions of Eastern Australia were preceded by an extensive peneplain of low elevation with isolated hills and ridges about 1,000 ft. high (Süssmilch, 1922, 203). In the upper Tertiary, this peneplain was apparently covered by a Rain-Forest similar to that which occurs in isolated parts of New South Wales and Queensland to-day. The climate was probably uniformly moist and warm throughout the region, and capable of supporting a luxuriant tropical vegetation.

During the "Kosciusko Epoch," at the close of the Tertiary period, a great epeirogenic uplift produced the existing tablelands, accompanied by faulting and folding, and formation of rift valleys; subsequent erosion partly dissected the tablelands and the present topography of Eastern Australia was developed, with its high north-south mountain chain, and generally east-west river valleys. The development of these highlands near the coast divided the State roughly into three regions with different climates, viz., a coastal zone with high temperature and high rainfall; a mountain zone with a dry cold climate; and a western zone with a dry, hot climate. This differentiation probably appeared at the close of the Tertiary period, and undoubtedly caused a restriction in the range of the Rain-Forest vegetation, which disappeared from the drier and cooler regions of the State and became entrenched in the sheltered valleys—especially those with an easterly aspect and warm moist climate—or on isolated sheltered areas of the tablelands, where rich basaltic soils and adequate rainfall and shelter provided a favourable habitat.

These basaltic outcrops, on weathering, produce a soil not only chemically rich, but also with a high water capacity. It is not surprising, therefore, that the tropical Rain-Forest types of Polynesian-Malayan origin colonized these lava flows, and became firmly entrenched upon them, for their primary necessities appear to be abundant soil-moisture and a sheltered habitat.

The retreat of the Rain-Forest from the hot or cold and drier habitats provided the opportunity for colonization by the endemic forms, which evolved elsewhere on the continent, probably in Western Australia, and migrated to the eastern region subsequent to the disappearance of the inland sea.

In New South Wales the Tertiary representatives of the endemic flora apparently flourished under more mesophytic conditions; at any rate the climate was probably more uniform and tropical throughout the State than it is to-day, and would favour the development of a richer mesophytic flora provided the edaphic conditions were favourable. In the lower Tertiary the surface soils were sandy, siliceous and porous on the one hand, and on the other, heavy and derived from the weathering of the Wianamatta Shale. The endemic types, perhaps, established themselves on the sandy soil, while the Malayan vegetation occupied the shales. The two habitats would be exposed to the same climatic factors, but the edaphic differences might have led to the development of different degrees of mesophytism. The Tertiary lava flows, on weathering, produced very rich soils in different parts of the State, and these formed an ideal and optimum environment for the Malayan Flora, which even in upper Tertiary times, must have been subjected to vigorous competition from the endemic forms. The primitive endemic flora of New South Wales appears, then, to have been mesophytic, and the xerophily of the present types is an induced character which has developed along with the climatic changes over the State, attendant upon the formation of the mountain blocks. At any rate, the uplift at the close of the Tertiary period provided a variety of climate which would stimulate xerophily. The denudation of the shales and Tertiary basalts from parts of the plateaux exposed the Hawkesbury Sandstone Series which, edaphically, provided a xerophytic habitat. Thus it appears from Tertiary times onwards, the edaphic and climatic factors have stimulated the progress of the endemic types from mesophytism to xerophytism, and have caused a great restriction in the range of the Malayan elements in New South Wales.

Geology and Physiography.

The Mount Wilson area is one of the basaltic residuals on which the Tertiary Rain-Forest has been preserved; it belongs to a series of basalt-capped peaks raised above the general level of the Blue Mountain Plateau. The basalt flow probably covered a considerable portion of the plateau in the immediate neighbourhood, but most of it has disappeared. The age of the basalt of Mount Wilson is not quite certain, but it probably belongs to the Older Basalts which survive as cappings on the residuals which rise in the form of isolated hills or long narrow ridges above the surface of the East-Australian Tertiary peneplain (Süssmilch, 1922, 199). The sandstone of the plateau, during Triassic times, was overlaid with Wianamatta Shales which were subsequently denuded from the plateau with the exception of restricted areas as far as Faulconbridge, and the cappings under the basalt of the isolated peaks. The basaltic coverings on these peaks—Mt. Tomah, Mt. King George, Mt. Tootie—appear to have protected the shales from complete denudation. Thus the isolated peaks are probably survivals of an original higher tract protected from denudation by the more resistant portions of the basalt sheet which flowed over the undenuded surface of the plateau (Carne, 1908). The isolated basaltic peaks are probably survivals of an original continuous sheet (David, 1896).

Mt. Wilson is a long ridge between the Bowen and Wollongambe Creeks, trending north-easterly. These creeks flow in deep gorges, about 1,200 feet below the summit of the ridge. Four parts of this ridge are capped with the olivine-basalt sheet, which probably was continuous originally, but is now divided by denudation into four isolated masses. The most important of these are Mann's Hill, 3,475 ft.; Wynne's Hill, 3,425 ft.; and Yengo, 3,345 ft. The basaltic cap varies in thickness from 135 ft. (Yengo) to 300 ft. (Wynne's Hill), while the estimated area of basalt aggregates 575 acres.

Weathering.—The larger crystalline masses of the basalt weather first and form vesicles or hollows, but frequently surface boulders weather more or less concentrically, and the fragments come away in conchoidal flakes. The soil produced by the weathering is of a rich chocolate colour. The rock has been studied petrologically by Card (1908), and the following features are taken from that description: The rock is an olivine basalt; the minerals present are augite, olivine, plagioclase felspar (labradorite ?) and magnetite, and are embedded in a light brown glassy matrix. The felspar microlites give rise by their disposition to a good fluidal structure floating round the porphyritic constituent. Olivine is abundant, and remarkably fresh. It occurs as porphyritic individuals, presumably from an earlier stage of crystallization, and numerous granules through the rocks. The augite has a tendency to assume a purplish tint and is slightly pleochroic.

The following analysis of the olivine basalt of Mt. Tomah, near Mt. Wilson, and probably part of the same original sheet, probably approximates to the Mt. Wilson rock. The analysis was made by J. C. H. Mingaye, and is quoted in the Memoirs of the Geological Survey of New South Wales, Geology, No. 6, p. 129.

Olivine-Basalt of Mt. Tomah.

Analysis.	
SiO_2	46.42%
Al_2O_3	17.42
Fe_2O_3	3.70
FeO	7.45
MgO	6.61
CaO	8.56
Na_2O	3.61
K_2O	1.80
H_2O (100°C)	0.34
H_2O (100°C+)	1.52
CO_2	0.04
TiO_2	1.88
ZrO_2	0
P_2O_5	0.87
SO_3	0
Cl	0.05
S(FeS_2)	0
Cr_2O_3	0.006
NiO, CoO	0.02
MnO	0.02
BaO	0.03
SrO	trace
Li_2O	0
V_2O_5	0.01
	100.35
Sp.Gr.	2.905

Molecular Constitution.	
Orthoclase	10.5
Albite	24.1
Anorthite	25.9
Nepheline	3.4
Diopside	9.5
Olivine	14.2
Magnetite	5.3
Ilmenite	3.6
Apatite	1.9

Nepheline not detected microscopically but must be present. Mn total exceptionally low for igneous rocks.

It will be seen from this analysis that the potash, phosphoric acid, ferrous and ferric oxides, magnesia, and lime content is very high. The basalt is thus exceedingly rich in the essential elements for plant nutrition, and on weathering produces a soil which supports a luxuriant vegetation, in striking contrast to that on the siliceous sandstone strata in close proximity.

THE VEGETATION OF MT. WILSON AS A WHOLE.

A consideration of the topographical features of Mount Wilson, as previously outlined, has led us to recognise for convenience three physiographic unit-areas, namely, (1) the basalt-capped hills with a rich moisture-retaining soil; (2) the sandstone tracts of the plateau with a dry and impoverished soil; and (3) the gullies which occur between some of the basalt hills and the valleys of the Wollangambe and the Bowen into which they lead.

This division has more especially commended itself since the vegetation tends to fall into three groups corresponding with these unit-areas. The flora of Mount Wilson is divisible into two main types, the Malayan and the Endemic, with a small and scattered representation of the Antarctic. The luxuriant Malayan vegetation, as has been mentioned earlier in the paper, finds a suitable habitat on the basalt caps, except where in certain areas exposure, or thinness of the basalt covering, has resulted in an invasion of endemic types. This vegetation also occupies the valleys, where it has a richer composition. The Endemic Flora, essentially xerophilous and adapted to a poor siliceous soil,

clothes practically the whole of the sandstone plateau and finds its chief expression in open sclerophyllous Eucalyptus Forest. Antarctic types occur both among the Malayan and Endemic Floras.

It is proposed to confine this paper to a description of the associations occupying the basalt caps, postponing the study of the remaining parts of the district for subsequent communications.

The Associations of the Basalt Caps.

The vegetation of the basalt comprises several interrelated associations, the distribution of which is determined largely by exposure. A dense and luxuriant Rain-Forest clothes the eastern slopes of the basaltic caps, and occurs also on level basalt tracts which are sheltered from the west by neighbouring hills; this can be regarded as the typical association of the volcanic soil. Near the edge of the basalt tract, as the rich soil begins to grow thin, the Rain-Forest loses its tropical character and becomes more open and increasingly permeated by an invasion of the endemic Eucalyptus from the sandstone; until eventually the Rain-Forest trees practically disappear, and give place to a Eucalyptus Forest with a tree-fern stratum. Thus a gradual transition from the one extreme to the other takes place, but none the less the extremes must be regarded as different communities. It has been found best to divide this vegetation into the following three associations:—

1. Ceratopetalum-Doryphora Forest.
2. Eucalyptus-Doryphora Forest.
3. Eucalyptus-Alsophila Forest.

The first and second of these are sub-tropical Rain-Forests, while the third represents the sclerophyllous Eucalyptus Forest with the tree-fern stratum.

In less favourable habitats the last two often occur without the first, while large exposed areas of the basalt caps are frequently occupied by the Eucalyptus-Alsophila association alone.

The Eucalyptus-Alsophila Forest usually ceases in a most abrupt and striking manner near the edge of the basalt and the region of the boundary between the two soils is occupied by a peculiar junction flora, composed of a Eucalyptus-Pteridium association.

Thus we recognise four associations in the basalt formation, but, as will be seen later, all are varying mixtures of the two main associations, namely, the Eucalyptus Forest of the sandstone and the Ceratopetalum-Doryphora Forest of the basalt.

The Ceratopetalum-Doryphora Association.

Habitat.

This luxuriant Rain-Forest occurs on the sheltered eastern slopes of the basaltic hills, and to this habitat it is confined. It cannot survive in any spot that is not completely sheltered from the desiccating west and south-west winds which sweep the opposite slopes with their full force. But exposure is not the only factor limiting the range of this largely mesophytic community, for it is only in the central portions of the basalt areas that the rich soil is deep enough, and the water content high enough, for the normal development of the Rain-Forest. Thus this association, although frequent, is not very extensive, except where it is continuous with the Rain-Forest in the gullies.

Structure and Physiognomy.

The association is dominated by *Ceratopetalum apetalum* and *Doryphora sassafras,* other trees being only occasionally present. These average about one hundred feet in height but are compact and narrow (Plate lx., fig. 10). This feature, combined with their proximity, dense distal mosaic of foliage and shining leaf surface, protects them largely from the extreme insolation to which the plateau is exposed, since all but the topmost branches are sheltered from the full force of the sun.

A second stratum is formed by the tree-fern *Dicksonia antarctica,* with an occasional tall shrub or small tree. The tree-ferns which are often so numerous that their fronds overlap, as is illustrated in Text-fig. 1, average about twelve feet in height, and lend a distinctive aspect of tropical luxuriance to the interior of the Forest (Plate lviii., fig. 1).

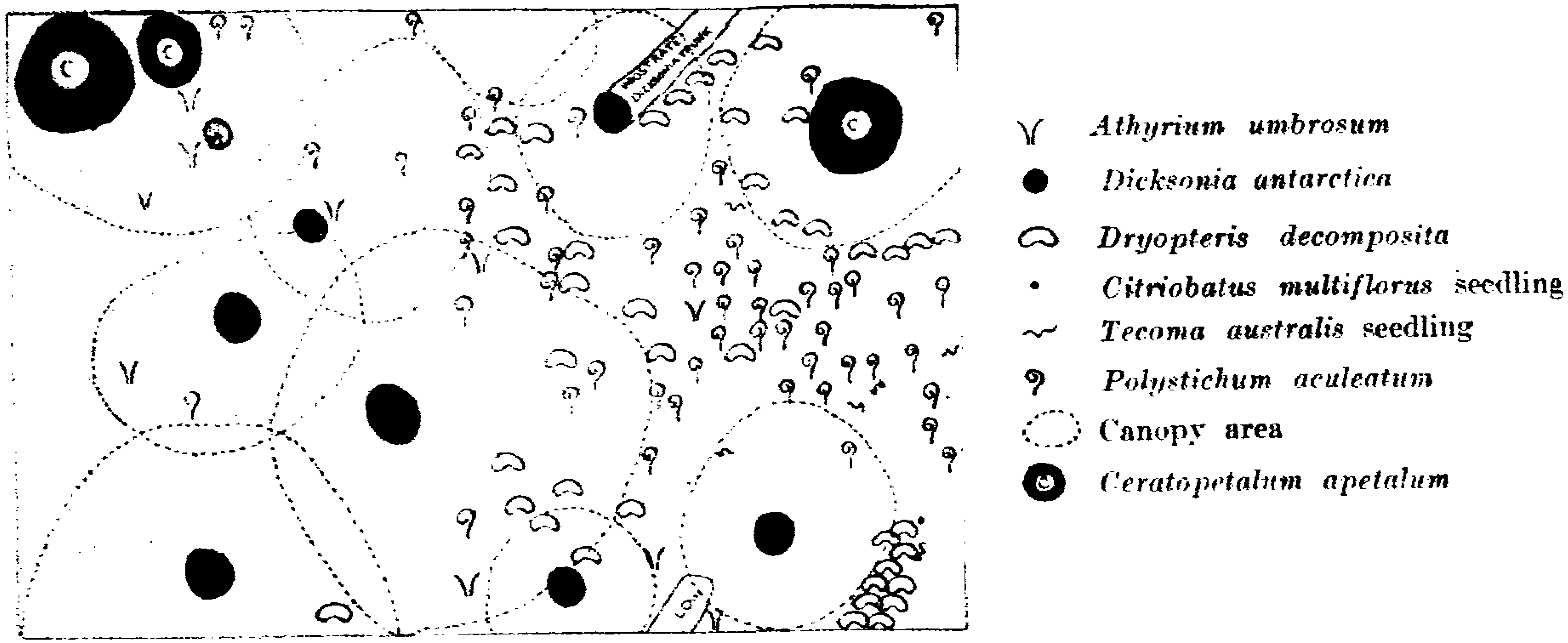
The canopy of foliage above and the screen of tree-fern fronds result in the lower regions of the forest being shrouded in gloom, especially when the sun has passed the meridian (Plate lviii., figs. 1 and 2). In these dark regions the forest floor is occupied by a fern-stratum, averaging two feet in height. This is frequently sparse, owing to lack of sufficient illumination, and a considerable amount of the ground is bare or carpeted with dead and decaying leaves; but wherever a chance opening in the canopy occurs, and a beam of sunshine penetrates the forest, the ferns form a closed society. Corresponding to these two conditions of illumination are two communities, namely, pure closed societies of *Blechnum discolor* under openings in the canopy (Plate lviii., fig. 1), and in the darker regions an open society of the remaining components of the fern stratum (see subsequent list). Text-figure 1 illustrates the distribution and composition of the lower strata, and shows how the vegetation of the forest floor tends to be massed in the areas between the shade of the tree ferns.

The frequent lianes and climbers constitute another feature of the Rain-Forest (Plate lviii., fig. 1). *Vitis* attains a great development and is often a foot in thickness. The other climbers are much more slender, but attain a considerable height. *Polypodium diversifolium,* in particular, may be seen on tree trunks a hundred feet above the forest floor, the lower parts having died away as upward growth proceeded.

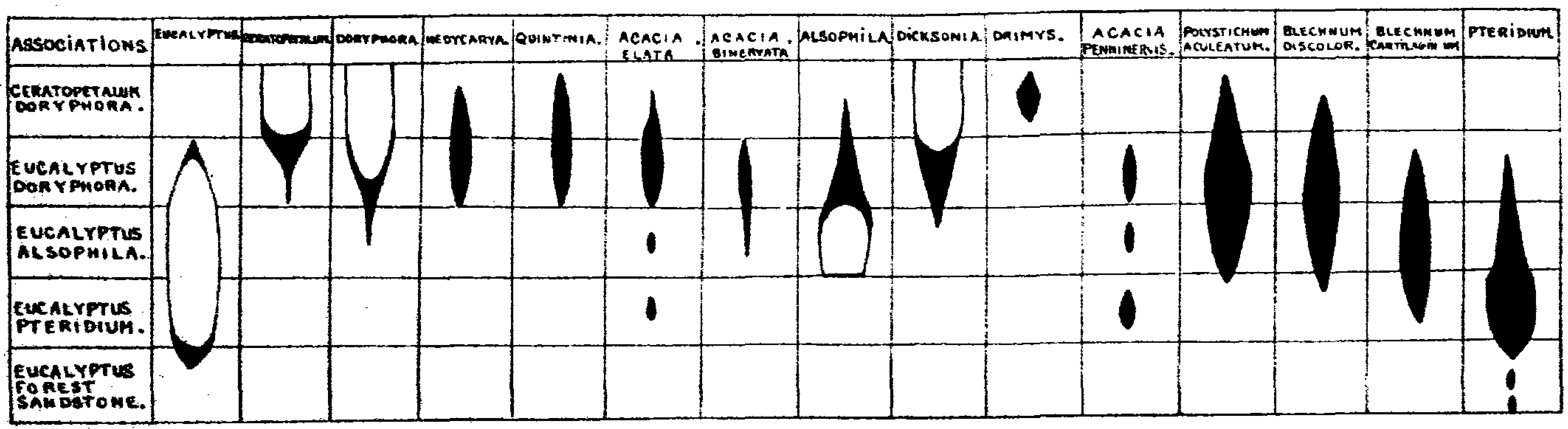
Epiphytes are common, the greater proportion being mosses and lichens which clothe the trunks of *Dicksonia* and the slim boles of the forest trees. There are also several orchids and Pteridophytes, amongst which are *Dendrobium pugioniforme,* the rare *Tmesipteris tannensis* (Plate lviii., fig. 3) and the delicate *Trichomanes venosum* growing in societies on *Dicksonia* trunks. A noteworthy feature, however, is the complete absence of *Asplenium nidus* and *Platycerium grande,* which occur in this association at Mt. Irvine, some six miles distant; this fact seems to be correlated with the lower altitude of the latter peak and its consequent milder winter, as in similar forests in other parts of the State with a mild climate these epiphytes are abundant.

One phenomenon of special interest is the occurrence of young plants of *Quintinia Sieberi* growing epiphytically on tree-fern trunks, among the tangled adventitious roots of which the seeds germinate. Subsequently, no doubt, the roots of the epiphyte reach and establish themselves in the ground. This is the only case of hemi-epiphytism encountered in the Rain-Forests at Mount Wilson.

Parasitism is not common, but mention must be made of *Viscum articulatum*



Text-fig. 1.—Chart of a portion of the Ceratcpetalum-Doryphora Forest, showing the tree-ferns with their overlapping fronds and the fern stratum clustering in the better illuminated regions. (Scale. 1 in = 8 ft.).



Text-fig. 2.—Diagram showing the approximate ranges and frequency of some of the more important species of the basalt flora. Dominance and sub-dominance indicated by white patches.

on *Doryphora sassafras*; *Loranthus*, so common on species of Eucalyptus on the sandstone plateau, was not observed on the basalt vegetation.

Floristic Composition.

Tree Stratum

Ceratopetalum apetalum Don. . d*
Doryphora sassafras Endl. .. . d
Hedycarya angustifolia Cunn. o-vr
Quintinia Sieberi D.C. .. .. o-vr
Atherosperma moschatum Labill. r
Acacia elata Cunn. .. .. r
Eugenia Smithii Poir. .. .. .. r

Tree-Fern Stratum

Dicksonia antarctica Labill. .. sd
Drimys dipetala F.v.M. .. .. . o
Citriobatus multiflorus Cunn. .. o
Hymenanthera Banksii F.v.M. . o
Alsophila australis R.Br. .. .. r

Fern Stratum

Polystichum aculeatum Schott. . c
Dryopteris decomposita Kuntze. f
Athyrium umbrosum Ait. .. .. f
Pellaea falcata Fée .. .. .. f-r
Blechnum discolor Keys .. .. . o
Dryopteris tenera Chr. .. .. .. r
Polystichum aristatum Presl. .. r
Dennstaedtia davallioides Moor. r
Blechnum Patersoni Mett. .. .. vr

Ground Stratum

Dawsonia sp. .. .. o in societies
Asplenium flabellifolium Cav. . r
Numerous fungi.

Climbers

Polypodium diversifolium Willd. f
Vitis hypoglauca F.v.M. .. .. .. f
Tylophora barbata R.Br. .. .. f-o
Polypodium pustulatum Forst. . o
Fieldia australis Cunn. (on *Dicksonia* trunks) .. .. o
Tecoma australis R.Br. .. .. f-o

Epiphytes

Trichomanes venosum R.Br. (in dense societies on *Dicksonia* trunks) .. .. f-o
Cyclophorus serpens Chr. .. .. o
Dendrobium pugioniforme Cunn. o
Dendrobium teretifolium R.Br. . o
Tmesipteris tannensis Bernk. . r-o
Asplenium bulbiferum Forst. .. .. r in this habit
Quintinia Sieberi D.C. (seedlings on tree fern trunks) .. .. . r-o
Polyporinae and other epiphytic Fungi.

Parasite

Viscum articulatum Burm. .. .. r on *Doryphora*

THE EUCALYPTUS-DORYPHORA ASSOCIATION.

Habitat.

The volcanic soil of the Ceratopetalum-Doryphora habitat is comparatively deep, but, as the periphery of the outcrop is approached, the layer of basalt superimposed on the sandstone becomes thinner, and finally disappears. This area, surrounding the Ceratopetalum-Doryphora Forest just described, does not seem to be so favourable a habitat for that association: the trees have a more open structure and some of the components become much less frequent or even disappear. The less vigorous hold of the Malayan vegetation on this habitat, resulting from the decrease in environmental favourableness, with its consequent more open structure and greater illumination of the forest floor, has given rise to certain changes in the vegetation, chief of which is the invasion of *Eucalyptus* trees from the sandstone.

The new association so formed often occurs as a thin fringe round the Ceratopetalum-Doryphora Forest, and on the borders of the road running through it. It also replaces the Rain-Forest on some of the basalt outcrops which are either not sheltered enough or too shallow to enable the Rain-Forest

* In these lists, a = abundant, c = common, d = dominant, f = frequent, l = locally, o = occasional, r = rare, sd = subdominant, vr = very rare.

to attain its optimum development and thus exclude invaders from the surrounding terrain. It may be that the unfavourable nature of the habitat is due to lower water content of the soil, since the rain would readily percolate through the sandstone lying beneath.

Structure and Physiognomy.

Although this Forest is largely a mixture of the Ceratopetalum-Doryphora and the Eucalyptus associations, taxonomically it must be regarded as a separate association. Its distinctiveness is shown by the fact that *Ceratopetalum,* not faring so well in the competition with the invaders as *Doryphora,* falls from the rank of a dominant to that of an occasional type. Moreover, on account of the admixture of *Eucalyptus,* with its spreading branches and pendulous iso-bilateral leaves, less light is obstructed, and the lower strata undergo consequent changes: the association is less tropical in physiognomy, but it nevertheless has a greater floristic richness; for the less specialised habitat allows a greater number of types, especially Angiosperms, to colonise it.

The trees fall into two strata. The *Eucalyptus* species, perhaps on account of the favourable edaphic factors, reach a height of about two hundred feet (Plate lix., figs. 5, 7), which is considerably more than that attained on the sandstone, and so dominate the association. A second layer, about one hundred feet high, is composed of *Doryphora,* which must now be regarded as subdominant, and several other trees. The latter, such as *Hedycarya* and *Atherosperma,* seem to be given a greater chance in the struggle for existence in this open forest: in the Ceratopetalum-Doryphora Forest the dominants give other types but little opportunity of spreading. These facts are shown strikingly in Text-fig. 2.

The increased light intensity in the lower strata, as has been said, causes profound modifications in structure. In the tree-fern stratum, not only is the extreme sciophyte *Drimys* absent, but a radical change takes place in the composition of the tree-ferns themselves. For, as the Forest becomes more open, the shade-loving *Dicksonia* becomes largely replaced by the more xerophilous *Alsophila australis* (Plate lix., fig. 7); and consequently the tree-fern stratum extends over a considerable vertical range, since many of the latter attain from forty to fifty feet in height. One magnificent specimen, indeed, growing on the edge of a clearing in the Rain-Forest was seventy feet high (Plate lix., fig. 5).

There is no sharp transition between the Ceratopetalum-Doryphora and Eucalyptus-Doryphora Forests: the one merges into the other gradually, and there are homogeneous associations lying midway between the two conditions we have chosen to describe here as types. It is in some of these midway associations that *Citriobatus* becomes abundant, perhaps because it is given a greater chance by increased insolation. It is accompanied in the same stratum by a number of other shrubs. This is a new stratum in the Forest which we may interpret as a response to the stronger light intensity. For the same reason, the representation of Angiosperms as a whole increases considerably in the Eucalyptus-Doryphora Forest.

There are also modifications in the fern-stratum. This now approaches more to a closed community with the exception of disturbed tracts, such as paths and roadsides, where the ground stratum takes its place. The more ombrophilous Pteridophytes, such as *Athyrium umbrosum, Dryopteris decomposita* and *Dennstaedtia* are absent; while *Blechnum discolor* here finds its most

favourable environment. *Polystichum aculeatum* is abundant because it is apparently a type somewhat indifferent to light intensity. In the more illuminated situations there is sometimes an abundance of *Blechnum cartilagineum*, a type which appears to be more xerophytic than *B. discolor*. These facts are clearly illustrated in Text-fig. 2.

The modifications in the lower strata of this part of the basalt vegetation are evidently due to the difference in the structure of the tree layer, which allows more light to reach the lower strata, thus affecting the humidity of the forest atmosphere, the moisture content of the soil and the transpiration of the plants themselves. The increase in the Angiospermic flora of all layers is striking. The vegetation is richer floristically, but it lacks the tropical luxuriance of the Ceratopetalum-Doryphora Forest. Thus lianes are absent, and in their stead are smaller creepers such as *Smilax* and *Clematis;* epiphytes, too, are less numerous.

Floristic Composition.

Tall-Tree Stratum

Eucalyptus viminalis Labill.	d
Eucalyptus sp.	d

Tree Stratum

Doryphora sassafras Endl.	sd
Hedycarya angustifolia Cunn.	f-r
Acacia elata Cunn.	o-r
Acacia melanoxylon R.Br.	o-r
Quintinia Sieberi D.C.	o-r
Ceratopetalum apetalum Don.	o-r

Tree-Fern Stratum

Alsophila australis R.Br.	f
Dicksonia antarctica Labill	f
Hymenanthera Banksii F.v.M.	o
Solanum aviculare Forst.	r

Shrub Stratum

Citriobatus multiflorus Cunn.	o-la
Panax sambucifolius Sieb.	o
Acacia penninervis Sieb.	r-o
Prostanthera lasianthos Labill.	lf
Senecio dryadens Sieb.	r

Fern Stratum

Polystichum aculeatum Schott.	a
Blechnum discolor Keys.	c-a
Pteridium aquilinum Kuhn.	c in more open parts
Blechnum cartilagineum Swartz	f
Pellaea falcata Fée.	f
Davallia dubia R.Br.	o
Rubus rosifolius Sm.	o
Gleichenia flabellata R.Br.	o
Helichrysum sp.	r

Ground Stratum

Geranium pilosum Sol.	a
Hydrocotyle asiatica L.	a
Acaena sanguisorba Vahl.	a-o
Stellaria pungens Brongn.	f
Dawsonia sp.	o
Stellaria flaccida Hook.	o
Galium umbrosum Sol.	o
Asplenium flabellifolium Cav.	o
Prunella vulgaris L.	o
Doodia aspera R.Br.	o

Climbers

Smilax australis R.Br.	f
Tecoma australis R.Br.	o
Clematis aristata R.Br.	o
Tylophora barbata R.Br.	o
Geitonoplesium cymosum Cunn.	r

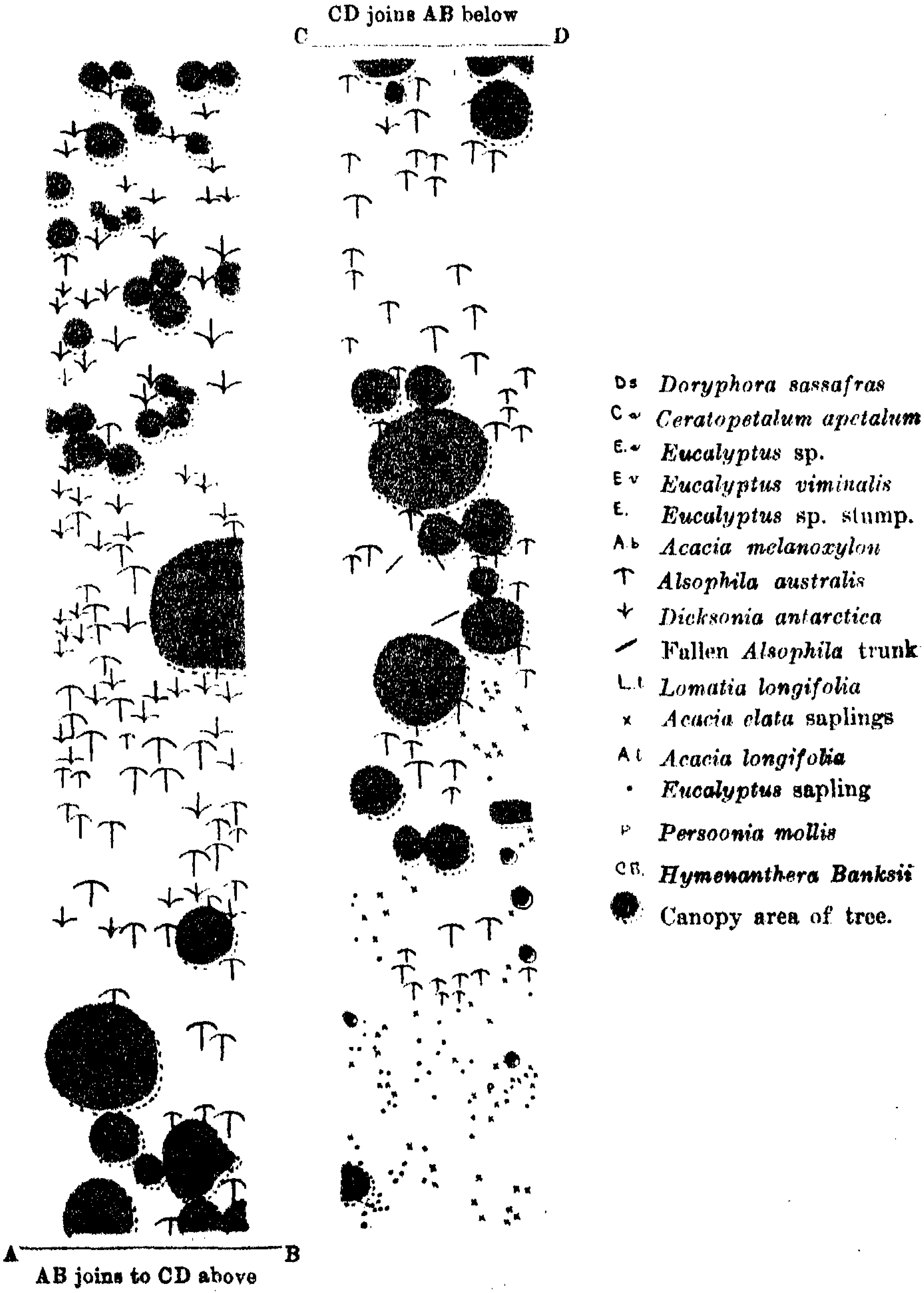
Epiphytes

Cyclophorus serpens Chr.	o

THE EUCALYPTUS-ALSOPHILA ASSOCIATION.

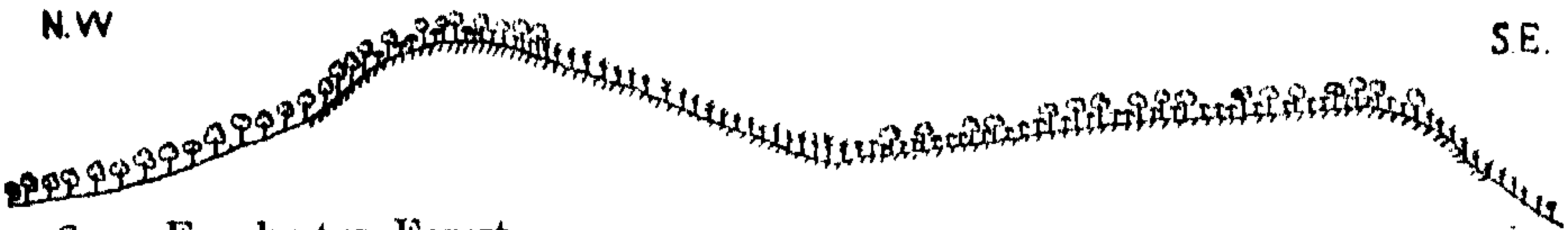
Habitat.

Still nearer the edge of the basalt than the habitat of the mixed forest is the third association, which has been called the Eucalyptus-Alsophila Forest. The same association is found on the summit and gentle western slope of a basalt hill which is more or less sheltered by a higher hill on the western side (see



Text-fig. 4.—Belt-Transect from Ceratopetalum-Doryphora Forest through the Eucalyptus-Alsophila Forest to the Eucalyptus-Pteridium association. (Scale, 1 in. = 50 ft.). The incidence of *Eucalyptus* with the Rain-Forest trees, and *Alsophila* with *Dicksonia* is illustrated clearly. It will be observed how the abundance of tree ferns varies with the intensity of light, being most abundant in open parts of the Eucalyptus-Alsophila Forest.

Text-fig. 3), but which, on account of its westerly aspect, cannot support the more luxurious associations. It also extends from the Rain-Forest over on to the western slopes of the basalt hills wherever the topography is such as to protect the habitat from the full brunt of the winds.



Eucalyptus Forest.

Eucalyptus-Alsophila Forest.

Ceratopetalum-Doryphora Forest.

Basalt Soil.

Sandstone Soil.

Text-fig. 3.—Diagrammatic section of the Mount Wilson ridge showing distribution of associations on the basalt. The Ceratopetalum-Doryphora Forest is seen on the sheltered south-east slopes of the hills.

Structure and Physiognomy.

This forest is another complex formed by the overlapping of the Rain-Forest types and the sandstone types (Text-fig. 2) but exhibits a much greater adaptation to a xerophytic environment.

In the tree stratum the Rain-Forest types are now absent, and the two species of ***Eucalyptus*** form an open well-illuminated forest. (See Text-fig. 4).

The tree-fern stratum is composed now chiefly of *Alsophila australis*, which is apparently the type best adapted to a heliophytic habitat, and flourishes abundantly, often forming a closed stratum. The association owes its physiognomy chiefly to this feature; for, on account of the open structure of the tree stratum, an unobstructed view is obtained of thousands of tree-ferns growing often in dense array (Pl. lix., fig. 8; Pl. lx., fig. 9). Many of these attain fifty feet in height; and it has been calculated, on the assumption that two circlets of fronds are produced each season, that such must average two hundred years in age.

Occasional saplings of *Doryphora* occur among the tree-ferns; but it seems unlikely that any succession in the direction of more luxurious structure will take place, since these communities have had ample time to attain the maximum degree of mesophytism which the habitats will allow. These saplings are particularly common over the face of the hill indicated on the right of the diagrammatic section (Text-fig. 3), at which junction a certain amount of oscillation appears to take place.

The remaining strata resemble those of the Eucalyptus-Doryphora Forest, except that some of the more sciophilous types such as *Citriobatus* are absent, and others, such as ***Polystichum aculeatum*** and ***Blechnum discolor***, are overshadowed by the ascendancy of ***Pteridium*** (see Text-fig. 2).

Floristic Composition.

Tall-Tree Stratum

Eucalyptus viminalis Labill. .. d-c
Eucalyptus sp. .. .. d
Acacia melanoxylon R.Br. .. .. o
Acacia elata A. Cunn. .. .. .. o

Tree-Fern Stratum

Alsophila australis R.Br. .. .. sd
Dicksonia antarctica Labill. .. o near Doryphora-Ceratopetalum Association.
Doryphora sassafras Endl. Saplings .. .. r-o
Banksia integrifolia L. .. .. .. vr

Shrub Stratum

Hymenanthera Banksii F.v.M. . o
Senecio dryadens Sieb. .. .. .. r

Fern Stratum

Blechnum cartilagineum Swartz. f-a
Blechnum discolor Keys. .. .. o-a
Pteridium aquilinum Kuhn. .. f-c
Gleichenia dichotoma Hook. .. o-f
Polystichum aculeatum Schott. o-f
Pellaea falcata Fée. .. .. o
Xerotes longifolia R.Br. .. .. . o
Davallia dubia R.Br. .. .. o

Ground Stratum

Geranium pilosum Sol. .. .. .. a
Hydrocotyle asiatica L. .. .. .. a
Stellaria pungens Brongn. .. .. f
Stellaria flaccida Hook. .. .. . o
Galium umbrosum Sol. .. .. .. o
Doodia aspera R.Br. .. .. o
Acaena sanguisorba Vahl. .. .. r

Climbers

Clematis aristata R.Br. .. .. .. r

The Eucalyptus-Pteridium Association.

(a) the typical association.

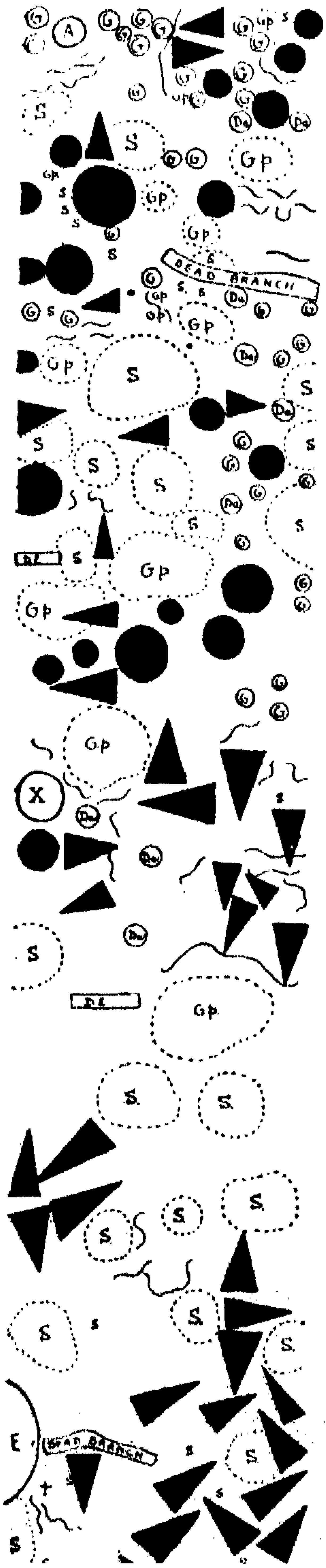
At a varying distance from the edge of the basalt, depending on how abruptly the rich soil diminishes in thickness, the forest of tree-ferns of the Eucalyptus-Alsophila association ceases abruptly, forming a barrier which, when viewed from a distance, is one of the salient features of the vegetation of Mount Wilson. The *Eucalyptus* species, however, continue uninterruptedly, and form a uniform stratum ranging from the Eucalyptus-Doryphora Forest on to the sandstone, where, owing to the incidence of other species, they become less frequent (Plate lx., fig. 9).

From the tree-fern boundary to some little distance on to the sandstone occurs a peculiar association which forms a junction between the typical plant covering of the sandstone and that of the basalt. One would expect to find a continuation of the overlap of the sandstone and basalt floras with a still increasing preponderance of the former; instead there are few of either, and the association is poor floristically.

The tree stratum is unchanged, while the shrub stratum is absent, except where there are societies, often dense, of *Daviesia ulicina* or *Acacia penninervis*.

The fern stratum, continuous with that of the Eucalyptus-Alsophila association, undergoes a complete change in structure. The *Blechnum* community extends beyond the tree-fern line to a certain extent, and, frequently, outlying patches of this community occur; but it becomes increasingly mixed with *Pteridium aquilinum*, which shortly becomes the dominant of the fern stratum of the Junction Flora.

The junction between the *Blechnum* community or the outlying societies, and the adjacent *Pteridium* community, is usually a sharp one, so far as the *Blechnum* is concerned, although the *Pteridium* is continuous throughout. Text-fig. 5 illustrates this point at the boundary of one of these outlying societies. In this chart



Alsophila australis trunk
Pteridium aquilinum
Blechnum cartilagineum
Gleichenia dichotoma
Xerotes longifolia
Doodia aspera
Dianella longifolia
Acacia elata seedling
Clematis aristata seedling
Stellaria pungens
Geranium pilosum
Tylophora barbata

Text-fig. 5.—Belt Transect across junction of ***Blechnum cartilagineum*** and ***Pteridium aquilinum*** societies in the Eucalyptus-Pteridium association. The structure of the fern and ground strata is clearly brought out; the greater concentration of the latter in the Blechnum society is interesting, suggesting that the occurrence of this society depends on more favourable habitat factors. (Scale, 1 in. = 4 ft.).

Blechnum discolor is absent: this fern seems to require more favourable conditions than exist on these outskirts, and does not often advance far beyond the tree-fern line. Thus in many places one passes from *Pteridium* to *Blechnum cartilagineum* which, further away, is replaced entirely by *B. discolor.*

Pteridium is associated with several sandstone types and also two other Pteridophytes, *Gleichenia dichotoma* and *Davallia dubia*, which were not observed further in towards the Rain-Forest. But perhaps its most conspicuous associate is *Lomatia silaifolia*, which, although not so conspicuous near the tree-ferns, becomes abundant nearer the opposite edge of the association.

Although comparatively poor in these strata, the Eucalyptus-Pteridium association has a rich ground stratum, which resembles essentially that of the associations previously described, although embracing a number of additional components.

Some hundred yards beyond the edge of the basalt, the Eucalyptus-Pteridium association slowly merges into the typical vegetation of the sandstone, characterised, in contrast to the former, by a profuse shrub stratum.

Floristic Composition.

Tree Stratum
Eucalyptus viminalis Labill. .. .. d
Eucalyptus sp. .. .. d
Eucalyptus piperita Sm.
.. .. l on sandstone
Acacia elata A. Cunn. .. .. .. lf

Tall Shrub Stratum
Eucalyptus sp. (saplings)
.. .. f (pyric succession)
Lomatia longifolia R.Br. .. .. .. r
Acacia penninervis Sieb. .. .. o-a
Daviesia ulicina Sm. .. .. .. o-la

Fern Stratum
Pteridium aquilinum Kuhn. .. sd
Davallia dubia R.Br. .. .. a
Lomatia silaifolia R.Br. .. .. f-a
Blechnum cartilagineum Swartz.
.. .. a near tree-ferns
Blechnum discolor Keys.
.. .. a in places
Polystichum aculeatum Schott.
.. .. .. c near tree-ferns only
Gleichenia dichotoma Hook.
.. .. f in places
Dianella sp. .. .. o
Xerotes longifolia R.Br. .. .. .. o
Mirbelia grandiflora Ait. .. .. vr

Ground Stratum
Geranium pilosum Sol. .. .. .. a
Galium umbrosum Sol. .. .. .. a
Hydrocotyle asiatica L. c
Tylophora barbata R.Br. .. .. .. f
Viola betonicifolia Sm. .. .. .. f
Stellaria pungens Brongn. .. .. o
Stellaria flaccida Hook. .. .. .. o
Doodia aspera R.Br. .. .. o
Oxalis corniculata L. .. .. o
Acaena sanguisorba Vahl. .. .. o
Poranthera microphylla Brongn. o
Brachycome sp. .. .. o
Cardamine hirsuta L. .. .. .. r-o
Clematis aristata R.Br. seedlings
.. .. r-o
Solanum xanthocarpum Schrad. r-o
Sonchus sp. .. .. r
Trifolium sp. .. .. r
Wahlenbergia gracilis D.C. .. .. r
Dipodium punctatum R.Br. .. .. r
Stackhousia viminea Sm. .. .. r
Lycopodium densum Labill. .. vr
Chiloglottis formicifera Fitzg. vr
Unidentified grasses .. .. f

(b) THE ASSOCIATION OF THE WESTERN SLOPES.

On the western side of the basalt capped hills exposure to the prevalent strong and parching winds usually prevents the Eucalyptus-Alsophila Forest from coming much over the hill from the eastern side, except in depressions or

in a bay protected by an adjoining headland. The Eucalyptus-Pteridium association thus extends further onto the basalt here than elsewhere, and, as was pointed out earlier, on account of the exposure, is much modified. As a matter of fact, however, it is a difference of physiognomy rather than composition. The structure is a more open one; for the ground is strewn with igneous boulders, suggesting that weathering here is slow, and the vegetation, except for the well adapted *Eucalyptus*, is scanty and stunted. The less xerophytic plants of the typical association, such as *Gleichenia*, are absent; and there is a greater abundance of grass, of which, however, a close examination has not yet been made.

This association, like the normal junction flora, has frequent dense shrub societies. These, however, are composed of *Pultenaea flexilis* and *Lomatia longifolia*. This is a remarkable habitat for the latter which, in Sydney districts, is a component of the mesophilous vegetation of creek banks. The association differs widely here in the composition of the ground flora; that of the typical examples of the association was also found in the Eucalyptus-Doryphora Forest and is, therefore, a mesophytic community which could not exist in so exposed a habitat as that under consideration.

This junction association, from what could be seen, extends, with little change, a long way down the sandstone slope towards the Wollangambe River. It is probable that the basalt soil washed down from above would inhibit the development of the ordinary sandstone flora.

In more sheltered parts of the slope the tree-ferns, as has been said, are able to come over the hill; and in such parts shallow water courses draining down into the Wollangambe bed are clothed with long tongues of the Eucalyptus-Alsophila Forest. In some cases no termination of these could be seen, and it is possible that they continue to the river at the bottom of the valley. This point will be investigated later when the valley formation is studied. The drainage channels, however, have probably carried basalt a long distance down the slope, which would enable the tree-ferns to exist in these places.

Floristic Composition.

Tree Stratum	
Eucalyptus sp.	d
Eucalyptus viminalis Labill.	d
Shrub Stratum	
Citriobatus multiflorus Cunn.	o
Pultenaea flexilis Sm.	f
Daviesia ulicina Sm.	o
Lomatia longifolia R.Br.	f
Fern Stratum	
Pteridium aquilinum Kuhn.	sd
Xerotes longifolia R.Br.	o
Lomatia silaifolia R.Br.	o
Davallia dubia R.Br.	o
Ampera spartioides Brongn.	o-r
Trachymene linearis Spreng.	r
Ground Stratum	
Hydrocotyle asiatica L.	o-a
Stellaria pungens Brongn.	o-a
Panax sambucifolius Sieb.	o
Doodia aspera R.Br.	o
Schelhammera undulata R.Br.	o
Dianella sp.	o
Clematis aristata R.Br. seedlings	o
Viola hederacea Labill.	o
Adiantum aethiopicum L.	o-r
Climbers	
Smilax australis R.Br.	o
Eustrephus Brownii F.v.M.	o
Geitonoplesium cymosum Cunn.	r
Hardenbergia monophylla Benth.	r
Billardiera longiflora Labill.	r

(c) THE STATUS OF THE ASSOCIATION.

A study of the structure of the junction flora leads one to speculate on the abnormal nature of the vegetation on the sandstone side of the borderline. That overlapping and invasion should take place on either side one naturally expects; but the problem of the absence of the characteristic shrubs of the sandstone flora is presented. The typical Eucalyptus Forest owes its facies largely to the remarkable shrub-stratum; but here between the tree tops and the ground, except for the somewhat restricted societies of *Daviesia* and *Acacia,* is little but a closed community about two feet high dominated by *Pteridium* and *Lomatia silaifolia.*

One of the most potent factors controlling the structure and development of the Eucalyptus Forests in Australia is the frequent occurrence of bush-fires. Round every junction the vegetation bears all the indications of having been recently burnt. The fire has crept up to the edge of the basalt, has in places passed through the Eucalyptus-Alsophila association, but has never transgressed the humid Rain-Forest.

We cannot escape the fact that the effect of bush-fires on the succession of vegetation is of considerable importance. In most countries and in most formations, the forest is entirely destroyed; a secondary succession then commences, beginning with a ground flora and gradually advancing once more to the climax association—sometimes even to a climax association dominated by different types from the original. The Australian Eucalyptus Forest, however, possesses the faculty of rapidly recovering from a bush-fire. Many of the defoliated and blackened trunks send forth new shoots, and by next season have entirely renewed their foliage. *Alsophila* can recover in a similar manner.

The bush-fire seldom destroys the climax association and so its effect is perhaps less striking than in other countries; but nevertheless profound alterations usually occur in the lower layers. Many of the shrubs are killed; and although it often happens that the same species grow up again to form the normal shrub stratum, frequently the first stage of succession is a community of *Pteridium aquilinum.* This occurs on the sandstone at Mount Wilson at some distance from the junction. No doubt some plants of this cosmopolitan and virile species were previously present in such localities; and when the fire destroys every living aerial shoot, the rhizomes of this plant are unharmed, and then, freed from the competition of its neighbours, it spreads apace and forms a closed community before the shrubs have time to recolonize the area. The same phenomenon has been observed in other countries.

These facts, then, offer an explanation for the structure of the Junction Flora which should not be overlooked.

It might, however, be urged that the richness of the soil at the junction inhibits the presence of the usual sandstone shrubs, and that only the limited number of types which occur there are adapted to these edaphic conditions; this is indeed what one would be led to expect from the highly specialised structure and metabolism which the sandstone shrubs have developed to fit themselves for their severe environment. Few species or individuals from the Eucalyptus Forest of the sandstone habitat have invaded the basalt.

In criticising this hypothesis we have searched for evidence of any further succession taking place. The societies of *Acacia penninervis* do not appear to

be a development from the normal Eucalyptus-Pteridium association, but have more the aspect of pyric societies contemporaneous with the Pteridium stratum. It is possible that the societies of *Daviesia ulicina* are a further development, but if so, it is not a development tending towards the typical Eucalyptus forest of the sandstone, since *Daviesia* is not a component of that association. It may be, however, that *Lomatia*, along with the few other sandstone types present, represents a development in the direction of the typical Eucalyptus Forest of that habitat.

Beyond this there is only one instance where the Junction Flora is richer and has the following composition:—

(x) *Leptospermum stellatum* Cav. f
(x) *Leptospermum flavescens* Sm. f
(x) *Acacia longifolia* Willd. .. a
Pteridium aquilinum Kuhn. . a-sd
Blechnum discolor Keys. .. f in patches richer in basalt
Polystichum aculeatum Schott. . f
Eucalyptus saplings .. .. a
Smilax australis R.Br. .. .. .. o
(x) *Cassinia denticulata* R.Br. . f
Acacia elata Cunn. .. .. o
Humea elegans Sm. .. .. r
Stellaria pungens Brongn. .. f-a
Goodenia ovata Sm. .. .. r
Hydrocotyle asiatica L. c
Blechnum cartilagineum Swartz. ... f in patches richer in basalt
Clematis aristata R.Br. seedlings r
Davallia dubia R.Br. .. .. f
Billardiera longiflora Labill. .. . r

Although a number of additional types are mentioned here, they do not approach within fifty feet of the tree-fern boundary, where the normal Eucalyptus-Pteridium association is unaltered. We may suppose that the sandstone types are always endeavouring to colonize the junction and this may be one place where they have partially, and perhaps only temporarily, succeeded. Even so, these remarks apply only to the four types marked with an x. The remaining additional types, *Humea* and *Goodenia*, are normal occupants of rich, moist soil, and one wonders only why they do not occur more frequently. *Billardiera longiflora* has already been mentioned as occurring at the junction on the north-west slope.

On the whole then, the Eucalyptus-Pteridium association may be regarded as a sub-climax; and further succession does not normally take place, a fact much favouring our second hypothesis.

The second source of evidence appears to lie in comparison with other basaltic plateaux. Shirley (1912) has recorded that, on Mount Tambourine in Queensland, a fringe of *Davallia dubia* marks the junction of the "scrub" and the forest. This type has not been recorded as a first colonist in secondary succession, but, being a heliophyte, might well be occupying a soil too rich for normal sandstone shrubs, which would explain its occurrence in the Junction Flora at Mount Wilson also.

In the absence of further data it is impossible to decide definitely which of the two hypotheses we have considered is correct; but we cannot avoid suggesting that although the bush-fires may have given *Pteridium* a greater ascendancy than usual, the absence of any further development in the constitution of the flora seems to indicate that the richness of the soil precludes the invasion of other types from the sandstone. *Lomatia* appears to be an exception, which is adapted to the prevailing edaphic condition.

The Flora of the Roadside.

The road leading through Mount Wilson on to Mount Irvine in many places cuts through the heart of the Rain-Forest, forming a narrow opening in the tree canopy, which allows the sun to illuminate the ground on the roadside. The result is the establishment of a more heliophilous plant community, consisting largely of low herbs and shrubs. The composition of the roadside flora is extensively modified by the anthropogenic factor; for the transport to and from the few orchards at Mount Irvine, along with the sowing of grass seed, has resulted in the introduction of many exotic genera. The same flora occurs also where the road passes through the more open forest of the basalt, and does not vary much in composition.

Floristic Composition.

Acaena sanguisorba Vahl. .. .. a	*Solanum nigrum* L. .. .. o
Sonchus sp. .. .. f	*Rubus moluccanus* L. .. .. o
Geranium pilosum Sol. c	*Anagallis arvensis* L. .. .. .. o
Taraxacum dens-leonis Desf. .. . c	*Asplenium flabellifolium* Cav. .. o
Pteridium aquilinum Kuhn. .. . c	*Helichrysum elatum* Cunn. .. . o
Hydrocotyle asiatica L. c	*Solanum cinereum* R.Br. .. .. r
Rubus fruticosus L. .. .. f	*Convolvulus marginatus* Poir. . r
Oxalis corniculata L. .. .. f	*Billardiera scandens* Sm. .. .. r
Euphorbia peplus L. .. .. f	*Solanum xanthocarpum* Schrad. r
Solanum aviculare Forst. .. .. o	*Goodenia ovata* Sm. .. .. r
Davallia dubia, R.Br. .. .. .. o	*Acacia penninervis* Sieb. .. .. r
Urtica incisa Poir. .. .. o	*Persoonia mollis* R.Br. .. .. . vr
Trifolium repens L. .. .. o	*Lomatia longifolia* R.Br. l
Trifolium pratense L. .. .. .. o	*Banksia integrifolia* L. l
Zieria Smithii Andr. .. .. .. o	

The Stability of the Associations.

It is difficult, from the data so far accumulated, to make any definite statement upon the stability of the associations dealt with, or to gain any clue as to possible succession, apart from the Junction Flora already discussed. The Doryphora-Ceratopetalum association is undoubtedly a climax; the dominance of the prevailing life-form is such as to maintain the association in its present state indefinitely under the existing conditions. The occurrence of the subordinates and the establishment of its own seedlings are definitely secured. A likely factor which would disturb the stabilizing control exerted by the dominating life-form would be the invasion of a superior life-form, which in the flora under review may prove to be *Eucalyptus;* and a Eucalyptus-Doryphora association exists around the Ceratopetalum-Doryphora Forest. The invasion of *Eucalyptus* produces a marked change in the structure of the community as is seen in the Eucalyptus-Doryphora Forest. Whether this invasion will involve the Ceratopetalum-Doryphora Forest cannot be decided at present; but one fact does appear striking, namely, the absence of seedlings of the species of *Eucalyptus* which have colonized the basaltic habitat from the Ceratopetalum-Doryphora association. This absence may be due to the extreme difficulty of the seedlings becoming established in this habitat owing to the unfavourable light factor; which makes it probable that under the prevailing climatic and physiographic conditions, *Eucalyptus* and other endemic genera will not seriously reduce the area of, or displace the Ceratopetalum-Doryphora Forest.

In the Eucalyptus-Doryphora association the structure and physiognomy changes and the luxuriance passes from the Ceratopetalum-Doryphora Forest. There is little doubt but that, if all the basalt be denuded from the residuals, leaving only the barren sandstone, the Rain-Forest Flora will entirely disappear from the higher parts of the plateau at Mount Wilson and be confined to the valleys where it exists at present.

Around the fringe of the dense Ceratopetalum-Doryphora association, a considerable amount of oscillation is evident. Here the basaltic covering on the sandstone appears to thin out considerably, and is occupied by the Eucalyptus-Doryphora association, whose structure and physiognomy have been described. Undoubtedly *Eucalyptus* is the dominant, but *Doryphora* is able to establish its seedlings in this area and so reaches the status of a sub-dominant.

Summary.

1. The vegetation of New South Wales is composed of three elements, viz., (1) an Endemic Flora consisting largely of Eucalyptus Forests and occupying the greater part of the State; (2) a Malayan Flora finding its chief expression in Rain-Forest; and (3) an Antarctic Flora which occurs as scattered individuals in certain regions.

2. The fossil evidence seems to indicate that the Malayan Flora emanated from the north in the early Tertiary, and spread through the greater part of eastern Australia. The Endemic Flora arose later, elsewhere on the continent, and gradually invaded the Malayan vegetation.

3. The differentiation of climate resulting from the uplift which occurred in Eastern Australia at the close of the Tertiary caused the Malayan Flora to recede to sheltered habitats with a high edaphic favourableness, while the endemic flora took its place by adapting itself to a xerophytic habitat.

4. Mount Wilson is one of a series of residuals of an ancient Tertiary basalt outflow and consists of a sandstone ridge with frequent caps of igneous rock.

5. The Malayan Flora is well represented on the sheltered slopes of the basalt caps and in the sandstone gullies; the endemic flora occupies the whole of the sandstone plateau.

6. The present paper includes an account of the plant communities occupying the basalt caps. The associations described are as follows:—

(a) The Ceratopetalum-Doryphora association which is the optimum expression of Malayan Rain-Forest.

(b) The Eucalyptus-Doryphora association, which resembles the above association modified to a certain extent by the invasion of the endemic *Eucalyptus*.

(c) The Eucalyptus-Alsophila association, a transitional association occurring in the neighbourhood of the edge of the basalt and containing only the hardiest Malayan types mixed with a limited number of endemic invaders.

(d) The Eucalyptus-Pteridium association which occurs at the fringe of the basalt and extends onto the sandstone. This association is not a normal transition since the development of such is prevented by certain factors discussed.

7. Possible cases of succession, and the factors which might give rise thereto are briefly discussed.

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EXPLANATION OF PLATES LVII.-LX.

Plate lvii.

Map of the Mount Wilson region showing the residuals, Mounts Wilson, Irvine (north-east of Mount Wilson), Haycock, Tomah, and Bell. The diagonal-hatching indicates the basalt caps.

(From the 16-mile map issued by the Geological Survey of New South Wales).

Plate lviii.

1.—Interior of Ceratopetalum-Doryphora Forest, showing the subdominant *Dicksonia*, lianes, an *Alsophila* and a society of *Blechnum discolor* under an opening in the canopy on the right.

2.—Interior of Ceratopetalum-Doryphora Forest, showing bare ground under canopy of a large *Ceratopetalum* on the left.

3.—*Tmesipteris tannensis* growing from a sloping *Dicksonia* trunk in the Ceratopetalum-Doryphora Forest.

4.—*Dicksonia* in the Ceratopetalum-Doryphora Forest.

Plate lix.

5.—Edge of a clearing in the Ceratopetalum-Doryphora Forest, showing closed canopy of foliage and an *Alsophila australis* 70 feet high in the middle distance. In the background are seen the tops of three gigantic *Eucalyptus* trees belonging to a Eucalyptus-Doryphora association beyond. *Pteridium* occupies the clearing in the foreground.

6.—Interior of Ceratopetalum-Doryphora Forest, showing *Dicksonia*.

7.—Eucalyptus-Doryphora Forest, showing tall *Eucalyptus* trees in the background and *Alsophila australis* in the foreground.

8.—Eucalyptus-Alsophila Forest. Note the tall trunks of *Alsophila* in the middle distance, and *Blechnum discolor* dominating the ground stratum.

Plate lx.

9.—Junction of Eucalyptus-Alsophila association (background) and Eucalyptus-Pteridium association (foreground). Note the abrupt cessation of *Alsophila*, and Pteridium dominating the ground stratum.

10.—Interior of Ceratopetalum-Doryphora Forest; note densely serried trunks of the dominants in the background, and *Dicksonia* on the right.

A FURTHER REFERENCE TO THE OCCURRENCE OF *MERISTA PLEBEIA* SOWERBY IN NEW SOUTH WALES.

By JOHN MITCHELL, late Principal of the Newcastle Technical College and School of Mines, N.S.W.

(Plate liii.)

[Read 24th September, 1924.]

The present reference to my record of the presence of *Merista plebeia* Sowerby in Australian rocks (These Proceedings, xlv., 1920) has been brought about by the attitude assumed towards that record by Professor W. N. Benson, of the University of Otago, N.Z. Professor Benson (Rec. Geol. Surv. N.S.W., x., Pt. 2, 1922) omitted my record of *Merista plebeia* from his extensive list of Australian Devonian fossils. Thereupon I wrote and drew his attention to the omission of this important Middle Devonian fossil, thinking at the time that the omission had been an accidental one. Professor Benson, in a courteous reply, informed me that the omission referred to had been intentional; because he considered that my determination was incorrect. Subsequently when a verbal discussion on the subject took place between us, he suggested that I had mistaken some Carboniferous brachiopod for a *Merista*. I therefore decided to submit duplicates of the brachiopods which had been determined by me as *Merista plebeia* Sowerby to an authority whose qualifications were beyond question and, in January last, I wrote to Dr. John M. Clarke, Director of New York State Museum, explaining to him the points in dispute between Professor Benson and myself, and asking him to act as arbiter between us. In his reply, Dr. Clarke makes the following remarks:—

"(1) *Merista plebeia* from the Eifel and elsewhere in the middle Devonian shales is, as a rule, a longer shell and a typical *Merista;* that is to say, its 'shoe-lifter' process is a single plate unsupported by a median septum.

"(2) The genus *Dicamara*, introduced by myself (Hall and Clarke, Palaeontology of New York, Vol. 8, Part ii., p. 73, Pl. 42, figs. 13-16), has a median septum supporting this central plate so that the umbonal chamber of the ventral valve is divided into two compartments.

"(3) *Dicamara scalprum* (F. Roemer) from the Middle Devonian of the Rhine, often in association with *Merista plebeia*, has this peculiar structure, and is the type of the genus. In it I can see no distinction from your species in structure or in form, I am disposed to believe that your species is identical with it.

"In a miscellaneous collection of specimens commonly referred to *Merista plebeia*, one would be quite likely to find specimens of *Dicamara scalprum*. In

fact this is the way in which the latter came to my attention as a distinct generic form and there is, therefore, good ground for your having identified your own species with *M. plebeia*."

The above opinion and explanations by Dr. Clarke are not likely to be challenged and leave little to be added by me.

However, it may be pointed out that before the establishment of the genus *Dicamara* J. M. Clarke, *Dicamara scalprum* was known as *Merista scalprum* F. Roemer and generally accepted to be identical with *Merista plebeia* Sowerby. Further, I was quite aware, that ultimately the fossil under discussion would be placed in the genus *Dicamara,* as the following remarks, in my rough copy of the original description of it, go to show: "It may happen later that additional evidence will prove the present form to belong to the genus *Dicamara* J. M. Clarke, for as stated above, there is a median septum in the brachial valve." The classification of our Meristoid fossil will now be as follows:—

Family MERISTELLIDAE Hall and Clarke.
Genus DICAMARA J. M. Clarke, 1894.

DICAMARA SCALPRUM F. Roemer.

Syn. *Merista plebeia* mihi (*non* Sowerby), These Proceedings, xlv., 1920, 544-5, Pl. xxxi., figs. 1-3.

To Dr. John M. Clarke my very sincere thanks are tendered for his kindness in undertaking the office of arbiter to settle the points of divergence placed before him; and for his examination and classification of the fossils submitted to him.

It has occurred to me that further proof of the Devonian age of the rocks from which *Dicamara* (*Merista*) *scalprum* was obtained might, appropriately, be added here, and consequently I add descriptions of three small Spirifers and an *Athyris* which in my opinion possess a true Devonic facies and which were found associated with *Dicamara* (*Merista*) *scalprum* Roemer.

SPIRIFER TULCUMBAHENSIS, n.sp. (Pl. liii., figs. 1-3.)

Shell of medium size, subrhomboidal or subpentagonal. Pedicle valve strongly convex, sulcus wide, shallow; ribs fourteen or more in number on each side of the medial fold, smooth, mildly convex, their obliquity laterally increases very gradually; interspaces shallow concave and equal in width to the ribs; beak prominent, incurved; umbonal ridges curved and reach the cardinal angles; cardinal area large, elevated and concave; cardinal angles rounded (?), dental plates conspicuous; delthyrium large and seems to be closed by the deltidium. Brachial valve subsemicircular, less convex than the other one, beak fairly prominent; medial fold low, indefinitely separated from the adjoining radials; in ornamentation it agrees with the ventral valve. When the outer lamellate layer of the shell is removed the valves are seen to be covered with fine radial striae, similar to those under similar conditions observed on the valves of *Martiniopsis subradiata* from Lower and Upper Marine beds (Permo-Carboniferous); but no concentric striae are visible on either valve. Dimensions: Length, 18.0; width, 20.0; depth, 12.0 mm.

The characteristic features of this Spirifer are (1) the thin flaky outer layer of the test, (2) longitudinal striae visible after removal of the surface lamellae, (3) indistinctness of the radials at and near their origin, (4) absence

of concentric striae, (5) faintness of the radials. The species has a decided Devonic aspect.

As far as I have been able to ascertain the Spirifer most closely related to the present species is *S. tullius* Hall from the Hamilton group (Devonic) of U.S.A. They agree in the following: (1) High cardinal area; (2) Plications rather flattened and low; (3) Whole surface covered with radial striae; (4) Sinus and fold extending quite to the beak, and smooth but for the fine radial striae. The local species differs from the other in (1) Having a weakly defined fold and sinus, (2) rounded cardinal angles (?), (3) curved umbonal ridges on the ventral valve, (4) terminal of the medial fold and sinus protrusive instead of emarginate, (5) lacking concentric striae, (6) greatest width some distance ventrally from the cardinal angles (?), (7) much smaller size.

On the foregoing differences the local form is separated from the American one.

Loc.—One of the foothills of the Bulga (an old volcanic vent) near the Bulga homestead, Parish of Gunnenbene, County Nandewar, N.S. Wales, associated with *Dicamara scalprum* F. Roemer (= *Merista plebeia,* Mitchell, *non* Sowerby), and *Orthis* (*Schizophoria*) *striatula.*

Horizon.—Middle Devonian.

SPIRIFER GUNNENBENENSIS, n.sp. (Pl. liii., figs. 4-6.)

Pedicle valve subrhomboidal, strongly convex or arched, slopes steeply from the beak to the lateral margins; ribs on each side of the sulcus are nine or ten, the pair bounding the sulcus being much stouter and more prominent than any of the others, all are convex and moderately prominent; concentric striae numerous, equally spaced and imbricate the radials; sulcus moderately deep, begins at the tip of the beak, concave, rounded in front; umbo prominent, high, and mildly incurved; cardinal area triangular, high, concave and reaches the cardinal angles; delthyrium narrow, partially closed by the deltidial plates. Brachial valve strongly convex, but less so than the pedicle, semicircular; radials similar to those of the pedicle valve; fold prominent, narrow, very definitely separated from the radials by pronounced furrows; beak inconspicuous. It may be added that the radials of both valves have a decided curve towards the lateral margins. Dimensions of two of the largest pedicle valves known: Length, 16.0, 15.0; width, 16.0, 15.0; depth, 8, 7.5 mm. A brachial valve measured 12.0 mm. long, 16.0 wide and 4.0 deep approx., and a small specimen with valves in apposition 11.0 long, 11.0 wide and 8.0 mm. deep.

The chief features of this species are (1) approximate equality of length and width, (2) proportionate great depth, (3) prominent radials abutting upon the sulcus, (4) high and prominent umbo, (5) prominent and curved umbonal ridges of the ventral valve, (6) radials rather strongly curving towards the lateral margins and (7) distinct separation of the fold of the brachial valve from the radials by pronounced furrows.

Locality and horizon the same as for the preceding species.

SPIRIFER WOODHOUSEI, n.sp. (Pl. liii., figs. 9-11.)

Whole shell small. Pedicle valve subrhomboidal, very strongly convex, especially towards the umbo, pyramidal. Radials five on each side of the sulcus, the fifth being faint; the sulcus pronounced and triangular; beak prominent, mildly incurved, pointed and suberect; umbonal ridges bow-shaped and just

reach the rounded cardinal angles; area relatively large and concave; delthyrium narrow and open. Brachial valve semicircular; radials similar in number and other respects to those of the pedicle valve; medial fold prominent, triangular in section; beak prominent. This valve is much less convex than the other one; traces of concentric striae are visible on both valves. Dimensions: Length, 9.0; width, 11.0; depth, 7.0 mm.

The striking features of this Spirifer are (1) its relatively large area, (2) prominent beaks, (3) bow-shaped umbonal ridges of the pedicle valve, (4) prominent and triangular sectioned medial fold and its definite separation from the radials, (5) the great depth, compared with the length and width of the whole shell. The shell here described is testless, and slightly damaged on one side; but for these imperfections it is a good specimen and unfortunately is singular.

The present species will fall into Hall and Clarke's division Radiati and group Pauciplicati of that division. The Spirifers belonging to this group, for the greater part, occur in Upper Silurian and Devonian rocks. It is therefore reasonable to assume that the present species is of Devonian age. This assumption is practically confirmed by its occurrence in association with *Dicamara scalprum* Roemer.

The species is dedicated to Mr. Woodhouse, at one time teacher of the public school at Gunnenbene and who, while on a visit to the Bulga with the writer, collected the specimen which forms the type of the species.

ATHYRIS BULGAENSIS, n.sp. (Pl. liii., figs. 12-14.)

Outline of complete shell pentagonal or subdiscoidal, each valve about equally convex; pedicle valve shorter than wide (11:12); radials absent; concentric striae distinct, evenly spaced and imbricated; a shallow sulcus developes towards the ventral margin; umbo subtumid; foramen distinct. Brachial valve slightly shorter than the pedicle one, but in other respects the two are similar except that on the brachial valve, owing to the removal of the outer layer of the test, the concentric striae are invisible; no median fold present. Dimensions: Length, 11.0; width, 12.0; depth, 8.0 mm.

This species is a neat one. In dimensional proportions and in some other respects it resembles *A. cora* Hall from the Hamilton group, Delphi, N.Y., but is only half the size of that species, and in some other respects differs from it.

Loc. and horizon: The same as for the preceding species, and is named after the homestead on which it was collected.

EXPLANATION OF PLATE LIII.

Spirifer tulcumbahensis Mitchell.

1, 2, 3. Views of the pedicle, brachial and front aspects (x 1.5, 1.5 and 2 respectively).

Spirifer gunnenbenensis Mitchell.

4, 5, 6. Views of a brachial valve and two pedicle valves, each more or less incomplete (x 2).

Spirifer sp. indet.

7, 8. Pedicle and brachial aspects (x 2 approx.).

Spirifer woodhousei Mitchell.

9, 10, 11. All showing the brachial aspect. Fig. 11 is a rough drawing of the shell restored. It shows the radials too distinctly (x 2).

Athyris bulgaensis Mitchell.

12, 13, 14. Pedicle, brachial and front aspects. The brachial valve, owing to the removal of the outer layer of the test, appears to be smooth (x 2).

All the specimens here figured are in the writer's collection.

A PRELIMINARY REFERENCE TO A NEW SPECIES OF *ELONICHTHYS* FROM THE LOWER BEDS OF THE NEWCASTLE COAL MEASURES.

By John Mitchell, late Principal of the Newcastle Technical College and School of Mines, N.S. Wales.

(Plate liii.)

[Read 24th September, 1924.]

Elonichthys davidi, n.sp. (Pl. liii., fig. A.)

The present remarks merely form a preliminary introduction to the description of the above species by Dr. A. Smith Woodward, to whom the original specimen of the fossil fish is being sent for that purpose. Already a good photograph of the fossil has been submitted to Dr. Woodward, who, at the writer's request, very generously determined its generic position as given above. In his letter conveying this information, Dr. Woodward further remarked that the species was new, and that it could be dedicated to Professor Sir Edgeworth David with safety, as this was the expressed wish of the writer. Dr. Woodward adds: "It must be one of the finest specimens of *Elonichthys* known."

As far as the writer is aware the above species is more ancient than any fossil fish yet recovered from rocks of Permian age in New South Wales.

Loc.—Near the junction of the Newcastle Coal Mining Company's railway with the Great Northern Railway of N.S. Wales, Parish of Tarro, County Northumberland.

Horizon.—About two hundred feet below the Borehole seam of the Newcastle Coal Measures. This horizon may be considered as belonging either to the lower beds of the Newcastle measures, or to the upper beds of the Dempsey Island division (David) of our upper Permian rocks.

EXPLANATION OF PLATE LIII. A.

Elonichthys davidi, n.sp.. (x ½).

NOTE UPON DETERMINING THE HYDROGEN-ION CONCENTRATION COLORIMETRICALLY, IN SMALL QUANTITIES OF FLUIDS.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

[Read 29th October, 1924.]

The acidity of a fluid depends upon the presence of free atoms or ions of hydrogen. In recent years, the concentration or strength of the fluid in these ions has been determined electrometrically and colorimetrically. Electrically, they are measured by their power to carry an electric charge and colorimetrically by the fact that certain colouring dyes alter in colour according to the number of active hydrogen ions in the fluid. The colorimetric method is the easier to perform and, as the colour changes have been standardised by the electrical method, there is reason to adopt the easier method for general work. As the acidity depends upon the free hydrogen ions, so the alkalinity depends upon the free hydroxyl ions and these in their turn have an influence in altering the colour of the dyes which thus act as standardised indicators.

Each dye alters in colour or dissociates over a certain range of acidity or concentration of the hydrogen ions but by employing a chain of dyes and noting the colour changes, we are able to determine the acidity over a wide field.

The general method of testing the active acidity is by adding a small quantity of a suitable dye to 5 or 10 c.c. of the fluid under examination, noting the nature and depth of the colour and comparing it with a solution of a known acidity, treated in a similar manner.

The values assigned to the strengths of acid are the logarithms of the hydrogen-ion concentration. For example, hundredth normal hydrochloric acid, (N/100), is 1/100 or 10^{-2}, the logarithm of which is -2 and for sake of convenience the negative sign is understood. Thus the pH value of N/100 hydrochloric acid is 2. N/1000 is 3 and so on. Neutrality is obtained at 10^{-7} or as it is written the pH value of neutral water is 7. As the numbers shorten, an increasing acidity is indicated and as they lengthen, the alkalinity increases. Normal sodium hydrate (N/1) has the pH value, 14.

With a large quantity of fluid at one's disposal, it is usual to employ test-tubes and a special holder or comparator. That is the usual method and it necessitates a considerable quantity of fluid. When, however, one has but a small quantity of liquid and that is precious, the use of test-tubes is out of the question. For example a fluid measuring 30 c.c. was undergoing fermentation and it was desired to test the reaction daily for from 20 to 30 days. Obviously a method had to be devised which would necessitate the withdrawal of only a minute quantity of the fermenting liquid.

The method adopted was to take a porcelain plate with six or twelve shallow depressions and from a burette to drop into each depression 0.45 c.c. of water, then to add a drop of a suitable dye. By means of a platinum spiral, a minute droplet of the fermenting liquid was abstracted and mixed with the diluted dye. With certain precautions the method was successful and the testing was expeditiously done.

The water was ordinary distilled water that had been boiled to two-thirds of its volume to expel carbon dioxide and ammonia. It was contained in an ordinary 200 c.c. burette furnished with a soda-lime trap at the top. This discharged 0.45 c.c. in six drops. The water below the stopcock was naturally run away before the drops were taken. The platinum spiral was made by taking the ordinary platinum-iridium wire such as is used in making infection needles and coiling it five times around a No. 18 B.W.G. wire. The coils were slightly separated. The helix when dipped into water abstracts and holds a minute drop the size of which can be determined. Those in use by the writer hold eight milligrams of water. After use they are dipped into clean water and ignited, as it is obvious that the presence of a trace of an ash constituent such as an alkaline salt would destroy their utility.

One spiral of fluid is mixed with the diluted indicator and then another is mixed and any change of colour is noted. If the colour is altered, another spiral of fluid is added. As a rule, one spiral is enough, but there are cases where two are necessary and sometimes more; much depends upon the buffering* of the solution. With a well buffered fluid such as is used in the standard solutions of tenth molecular citrate and phosphate, one loop is ample, but in solutions not so well buffered more than one may be necessary.

Clark † says that a dilution of 1:8 or 1:16 is permissible, but I find that one can go further, down to 1:32 and even 1:64 in a well buffered liquid. In a non-buffered fluid, dilution may not be justifiable. For example, a tempered tan-bark was digested with hydrochloric acid and washed with water; the second washing had a pH value of 3.2 by the tube method when undiluted. By the plate method the undiluted fluid was also 3.2 but in dilutions of 1:1, 1:2, 1:4, 1:8 and 1:16 the pH values were 3.4, 3.6, 3.8, 4.2 and 4.4 respectively. Obviously one has to be careful in using the method.

The colour shows up well on the porcelain tile and the pH value is determined by using a neighbouring depression for holding the same quantity of water, coloured with a drop of the same dye and treated with a droplet of a standard buffered solution. The determination should be quickly done as the colours soon fade.‡

Many of the formulae for preparing standard buffered solutions give odd

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* Buffer substances include peptone, proteins, amino-acids and the salts of weak acids such as phosphates, citrates, borates, bicarbonates. They "soak up" the excess of ions much as a sponge soaks up water. They regulate the acidity by taking up "hydrogen ions so that the addition of moderate quantities of acids make a comparatively small change in the reaction of the fluid." (The Reaction of Media. Special Report Series No. 35. H.M. Stationery Office.)

† The Determination of the Hydrogen-Ion Concentration.

‡ Haas (see Clark, op.cit.) devised a spotting method in which a drop of the fluid is mixed with a drop of indicator dye on a sheet of white opal glass. Drops of standard solution are spotted around this drop and these are coloured with the dye and compared with the test drop.

fractions of the pH values. In such cases one may prepare graphs and from them use the quantities of salts which will give whole numbers and rises of 0.2. In making these solutions, one is advised to recrystallise the saline components such as citric acid, and the phosphates of potassium and sodium. It is much easier and perhaps more satisfactory to use the ordinary pure crystals and to test the ionic strength of the solutions by the double tube method elaborated by Gillespie (Soil Science, ix. (No. 2), 1920, 115). For example, mixtures of M/10 citrate of soda, M/15 sodium phosphate, M/15 potassium phosphate and N/10 hydrochloric acid give solutions with pH values ranging from 1.2 to 8.6. The citrate of soda should have a pH value of 4.9 and, if it differs from this, citric acid can be added until this value is obtained. As an instance, 21 grams of citric acid were dissolved in water, 200 c.c. of normal sodium hydrate were added and the volume brought to a litre. The pH value was more alkaline than 4.9 but was corrected by the gradual addition of 2.6 grams of the citric acid crystals. Mixtures of this citrate with N/10 hydrochloric acid and M/15 sodium phosphate so as to make the values 3.8, 5.8, 6.6 and 7.2* were found to be correct when tested against the Gillespie method. In preparing the M/15 sodium phosphate and the M/15 potassium phosphate, the pH values of which should be 9.2 and 4.5 respectively, the ordinary salts were used and a correction was found to be unnecessary.

The recognition of the colour tint is facilitated by having a series of paper squares painted with water colour to match as nearly as possible the tint of the standard solution. The matching of a dichroic colour such as is obtained with brom-cresol purple is not easy, but one can get a close approximation by putting one colour upon another. The colours of all the other dyes are comparatively easy to match.

In making these colour tints, the liquid colour, instead of being painted on the paper with a brush, may be spread uniformly by placing a pool of the blended pigments on paper and drawing the fluid along the surface with the edge of a microscopic slide held at an angle. Tints around the colour desired must be prepared, as the pigments alter upon drying. When dry, they are compared with the colour produced by adding a droplet of the solution of standard pH value to the water and dye in a porcelain depression and the corresponding tinted paper is picked out and retained.†

To be able to utilise only a minimum quantity of nutrient fluid for testing the pH value it is necessary that the solution should have a sufficiency of salts or other substances which act as buffers, enabling one to dilute the liquid and yet obtain a knowledge of the active acidity or alkalinity. Exactly how much of these it is desirable to have can only be determined by trial, but the following may give some indication.

In testing the fermentative activity of the high temperature organism of fermenting tan-bark, a solution was prepared containing potassium monohydrogen phosphate 0.5, potassium dihydrogen phosphate 0.5, magnesium sul-

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* These values are about midway in the effective range of colour for bromphenol blue, brom-cresol purple, brom-thymol blue and phenol red by the Gillespie double tube method.

† The use of tinted paper for comparing the colours of the dyes is supported by Clark, who gives a set of colours in his book, and I have seen similar coloured paper in use in the Lister Institute for controlling the initial reaction of nutrient agar.

phate 0.15 and sodium chloride 0.15 grams per 100 c.c. As a source of nitrogen and carbon, each flask of 30 c.c. received one c.c. of water containing 0.05 gram each of lactose and peptone. Thus the fluid contained 1.2% of saline matter. The fluid was diluted in certain proportions and the figures below show the carbon dioxide given off; they are the average of two determinations.

The Fermentation of Lactose in a well-buffered solution. Carbon dioxide in mg.; aggregate amounts.

Days	1	2	3
1. Salinity 1.2%	15	37	53
2. „ 0.8	14	39	55
3. „ 0.6	14	36	54
4. „ 0.4	12	40	55
5. „ 0.2	8	30	46

In testing the acidity, the first three could be diluted 1:60, the fifth 1:30 and the fourth probably 1:50 as, although two spirals were taken, a little more than one would have done.

It is clear therefore that a salinity of about 0.5%, if the bulk of it consists of phosphate, is good for obtaining an optimum fermentation and for determining the acidity in small quantities of the fermenting liquid.

The case is different when the solution contains a minimum of buffering substances. For example, a modified Uschinsky solution was prepared and tested. It contained ammonium sulphate 0.37, sodium chloride 0.5, magnesium sulphate 0.02, calcium chloride 0.01 and potassium acid phosphate 0.1%. The salts totalled 1%. The original acidity of pH 5.6 was neutralised with dilute soda and 0.1 gram of lactose was added to each 30 c.c. portion in the fermentation flask.

The fluids became acid as the fermentation progressed, much more so than with well-buffered solutions. One set was neutralised on the second day.

The Fermentation of Lactose in a poorly buffered solution. Carbon dioxide in mg.; aggregate amounts.

	Neutralised			Not neutralised			pH value.		
Days	1	2	3	1	2	3	1	2	3
Undiluted, salinity 1 %	9	37	63	9	38	58	6.3	5.6	5.1
Diluted one half, salinity 0.5 %	8	24	43	4	24	29	6.0	5.7	5.2
Diluted one quarter, salinity 0.25 %	8	24	48	1	6	20	6.8	6.0	5.2

In the previous table, the buffered fluids had a pH value of 6.8 at the start and they never became more acid than 6.7, whereas in this badly buffered fluid the acidity rose to 5.1. As the fluid with the high saline content, whether neutralised or not, gave the largest yield of carbon dioxide, it is clear that in the absence of buffer salts a high saline content is necessary. The neutralisation of the acid fluids is advisable.

In testing the hydrogen-ion concentration, the fluids could not be diluted more than 1 in 4, 1 in 3 and 1 in 2 for the 1%, 0.5% and 0.25% respectively, when using brom-thymol blue and brom-cresol purple. This emphasises the importance of having a sufficiency of buffer substances in the fermenting fluids when it is desired to test the active acidity in small quantities of the fluids.

The dilution of the buffered solutions is only applicable when the sulphonephthalein dyes are used as indicators. With the acid ranges for which such a dye was not obtainable, the solution could not be diluted to any extent. Methyl red, for example, did not give true readings when diluted more than 1 in 3, while, in a solution of the same nature, brom-cresol purple, brom-thymol blue

and phenol red gave true indications in dilutions of 1 in 60. There was need therefore of a dye to replace methyl red. This has been met by the introduction of brom-cresol green by Cohen (Abstr. Bact., vii., 1923, 3).

A quantity of brom-cresol green was obtained and tested. It has rather a feeble tinctorial power, but a drop of 0.16% solution in water gave a good working colour. Its range is from pH 4.0 to 5.6, and it fits better in between brom-cresol purple and brom-phenol blue than methyl red. Like the other sulphone dyes, it acts well in dilutions of 1 in 60.

Thymol blue and brom-thymol blue also have feeble tinctorial powers but a 0.08% solution in water has been found to act well by the porcelain tile method in both cases. The other dyes are used in 0.04% aqueous solution and a drop is enough to give a good depth of colour in the half c.c. of liquid.

In poorly buffered solutions the porcelain tile method can be used, but the solutions may not be able to be diluted.

Frequently one has to work with coloured liquids and if these have been well buffered the colour may be so minimised by dilution that a determination may be made. According to Hind (J. Inst. Brew., 30, 1924, 57), dark coloured solutions as well buffered as wort may be diluted from five to ten times and stout may be diluted up to forty times without appreciable error.

Sometimes it is desirable to know the approximate acidity of an agar medium on which bacteria have been growing. This can be easily done. By means of a platinum spade or similar implement, a portion of the agar slope or plate is dug out and transferred to the depression of a porcelain plate or tile. It is chopped into fragments and these are distributed in a few of the other depressions. Water is added to each depression and the acid or alkaline salts soon diffuse into the fluid.* On the addition of a drop of indicator dye the reaction is determined.

Summary.

By using well-buffered solutions in fermentation experiments, small droplets (= 1/100 c.c.) may be abstracted and mixed with 0.5 c.c. of water held in the depression of a porcelain plate. On the addition of a drop of a suitable dye, the active acidity can be determined, either by comparison with a drop of fluid of standardised hydrogen-ion concentration added to water in a neighbouring depression or by means of a series of coloured papers.

With poorly buffered solutions, dilution becomes impossible, but the plate with 0.5 c.c. of solution gives a fairly accurate picture of the acidity.

Portions of agar slopes may be soaked in the 0.5 c.c. of water which soon becomes charged with the active ions and the colorimetric test can be made.

* Henriques (through Abst. of Bact., vii., 1923, 390) adds carbon dioxide-free water to the agar slants and after 45 minutes determines the pH of the water.

CRITICAL NOTES ON THE TEMNOCEPHALOIDEA.

By Prof. W. A. Haswell, M.A., D.Sc., F.R.S., Emeritus Professor of Biology, The University of Sydney.

(Plates liv.-lvi.)

[Read 26th November, 1924.]

Introductory.

Since the beginning of the century a number of important additions have been made to our knowledge of this section of the Platyhelminthes, and the question of the relationships of the group and its constituent members has been frequently discussed. Of these more recent original contributions, the most comprehensive have been those of Monticelli (1902), Wacke (1903) and Merton (1914). But Mrázek (1906), Annandale (1912), Gravely (1913) and Plate (1914) have also added to our knowledge in various ways.

A revision of the subject in view of the newer literature and with the aid of a considerable quantity of material from various sources has resulted in the conclusion that, in a number of points of greater or less importance, the published accounts of the group require amplification and correction before our knowledge can be regarded as in any way adequate. The present paper is an attempt to contribute towards the greater completeness of our knowledge with regard to the female reproductive apparatus, more especially the "receptacula," of *Temnocephala.*

My drawings have been re-drawn, for the purpose of reproduction, by Mr. F. W. Atkins of the Technical High School, Sydney.

I am indebted to the Senate of the University of Sydney for a grant from the McCaughey Research Fund which has defrayed the expenses incurred.

I. The Female Part of the Reproductive System of Temnocephala.

The female reproductive apparatus is composed of the *vitellarium* and its ducts, the *germarium* with the *germiduct,* the *reservoir* with its *duct* into which the germiduct and main *vitelloduct* open, giving rise to the *oviduct* which enlarges ventrally to form the *ootype,* opening, with or without an intercalated vagina or metraterm, into the *genital atrium.*

A. Description of the Parts in T. fasciata.

The genital aperture leads into the *atrium*—a chamber common to the male and female parts of the sexual apparatus. The left-hand portion of the cavity is occupied by the free part of the penis. The right-hand (female) part is capable of being greatly distended, so as to accommodate a completed egg, which

is here detained for a time before being passed out—probably to permit of the hardening of the newly secreted egg-shell. Around the genital aperture, both outside and inside, the integument is perforated by the numerous ducts of the unicellular cement-glands producing the substance by means of which the eggs, on discharge, are cemented together and to the surface of the crayfish-host. The surface integument is continued into the atrium, but soon undergoes modification: the nuclei of the epidermis disappear and the cuticle becomes thinned out. The muscular layers are in continuity with those of the general body wall, interrupted only by a sphincter surrounding the aperture.

Perforating the wall of the atrium in the right-hand portion are a number of ducts of unicellular glands corresponding closely to the ootype glands, but with the ducts not dilated terminally.

The *ootype* (*uterus*) (Plate lv., figs. 8 and 9, *u*) opens directly into the right-hand part of the atrium—the aperture surrounded only by a slightly developed sphincter. In its ordinary condition the ootype is bent on itself and folded, but is capable of being distended so as to enclose an egg during the process of formation of the egg-shell. Its wall consists of (1) muscular layers (external circular and internal longitudinal), (2) epithelium, (3) cuticle; and is perforated by the very numerous ducts of the *ootype-* or *shell-glands*. The epithelium is non-nucleated and syncytial. The cuticle is reduced to a thin perforated layer which in sections has the appearance of a fringe along the inner surface of the epithelium. There are no vibratile cilia in any part. A great part of the thickness of the wall is taken up by the terminal parts of the ducts of the shell-glands, each of which is dilated as it passes through into a rounded bulb with a clear, firm, cuticular wall. Almost invariably, droplets of coagulated secretion, little stainable by ordinary methods, appear in sections, issuing from the openings of the ducts or massed in the lumen of the ootype. In certain conditions the ducts of many of these glands have each two dilatations, the one in the substance of the wall of the ootype and the other just outside the latter.

The *shell-glands* (*ootype-glands*) (*sg.*) are unicellular glands of very irregular shape—in general pyriform—which lie around the ootype in an irregular zone. On an average these glands are about .05 to .1 mm. in diameter and the single nucleus of each is about 0.013 mm. in diameter. Usually each is distinct from the rest and its duct is a process given off centrally to open into the lumen of the ootype; but the bodies of neighbouring cells sometimes coalesce and occasionally union takes place between ducts.

The ootype lies to the right of the middle line. Its general direction is cephalad and dorsad. In front it narrows and bends to the left to become continuous with the *oviduct*. The latter (*od.*) is a comparatively narrow tube with small lumen, muscular wall, and an epithelial and cuticular lining thrown into slight longitudinal folds. Along one side is a ridge-like thickening of the epithelium. The ducts of unicellular glands which are uniform with the shell-glands open into the oviduct at intervals and are numerous on the ridge: these are devoid of the terminal enlargements occurring in the case of the ootype-glands. Since, in sections of specimens with an egg *in utero*, the appendage or filament of the shell lies in the oviduct, it appears probable that the function of these oviducal glands is the secretion of the filament. The oviduct runs to the right and dorsad, and then bends forward to open into the reservoir (*r*), piercing the dorsal and posterior wall of the latter. As it does so, it loses its muscular layers, and its cuticle alone is prolonged, as a very fine tube, the terminal part

of which (Plate liv., fig. 3 and fig. 7) with a lumen only 0.003 mm. in diameter, projects into the cavity of the reservoir and opens into it. This terminal tube, which I will refer to here as the *mouth-piece* of the reservoir, is so fine and so brittle that it is readily destroyed in section-cutting, and when preserved is easily overlooked, unless the sections happen to have been cut in a direction parallel to it. In favourable sections such as those represented in figs. 3 and 7, there is distinguishable a narrow stream of spermatozoa with other matter passing through the tube into the lumen of the reservoir.

The *reservoir* (Plate liv., figs. 1 and 2, *r.*) is a large vesicle about 0.5 mm. in diameter (about a tenth of the length of the animal in the fixed condition) situated in the middle line immediately behind the intestine and rather nearer the dorsal than the ventral surface of the body. Its wall, in addition to an investing layer of muscle, consists of a protoplasmic layer without trace of cell boundaries and with only a small number (about twenty-five) of large nuclei about 0.02 mm. in diameter. The protoplasm is normally structureless without fibrillations or networks and, save exceptionally, without vacuoles or canals. The contained cavity is in most instances quite undivided, but in a small proportion of cases a partition composed of the protoplasmic wall partly cuts off the portion from which the oviduct opens from the rest.

In the neighbourhood of the point where it enters (or leaves) the reservoir, the reservoir duct is surrounded by six or seven large cells (*m*) with nuclei 0.02 mm. in diameter. These are the myoblasts of the muscular fibres of the wall of the oviduct and have been hitherto overlooked or misinterpreted.* Each gives off a large process of fibrillated material which enters the wall of the duct and passes into the circular and longitudinal fibres of the latter. A short distance behind the zone of the myoblasts are four short blind diverticula (*r.s*) of the lumen of the duct which invariably contain spermatozoa. These correspond to the structures first discovered by Merton (in other species) and called by him *receptacula seminis* (1913, 1914). In *T. fasciata* they are small rounded vesicles, about 0.03 mm. in diameter, not free from the wall of the duct as in the species in which they were described by Merton, but actually contained within it, surrounded by its muscular tissue. Each leads into the lumen of the duct by a short narrow canal directed forwards, i.e., towards the reservoir.

Close to the so-called *receptacula seminis*, but further away from the large reservoir, is the opening of the germiduct. This is a mere funnel for the passage outwards of mature ova from within the capsule of the germarium to the oviduct. Close to this also is the opening of the main vitelloduct formed by the union of the right and left vitelloducts. The right and left main vitelline ducts converge inwards and backwards, and unite to form the short, approximately median, unpaired duct, which runs backwards and opens into the oviduct close to the junction of the germiduct and reservoir duct and of the receptacula seminis of Merton (Plate lvi., figs. 13-15, *vdl.*, *vdm.*, *vdr.*). The position of the opening of the main duct thus differs widely from that described and figured by Merton (1914) in the case of *T. rouxi*, and agrees with the earlier descriptions of Weber (1889) and Monticelli (1898). These main right and left unpaired ducts in this species (*T. fasciata*) have quite definite walls and are readily traceable in sections even when empty: but in no part is there a definite internal cuticle.

* The only record I have found of these cells is in Merton's fig. 46 f of Tafel 4 (1914), where two of them are shown, but are lettered *otpdr* (ootype glands).

The germarium and vitellarium have been described in sufficient detail elsewhere and differ little in essential characters in the various species.

B. Description of the parts in T. comes and T. simulator.

T. comes is an invariable companion of *T. fasciata* on the surface of the widely distributed Australian Crayfish—*Astacopsis serratus*. It differs very widely from its larger companion, not only in the absence of colour and the presence of six tentacles in place of five, but in the structure of its reproductive system. A feature in the male part of the apparatus in *T. comes*, which is important in its bearing on the structure of the female part, is that the spermatozoa become aggregated in packets or spermatophores, each enclosed in a thin case. These are formed in the posterior testes, pass along the exceptionally wide vasa deferentia to the vesicula seminalis, and are found in the ootype and oviduct, where the cases become ruptured, liberating the spermatozoa. The structure and development of these spermatophores have not yet been followed.

The ootype of *T. comes* (Pl. lv., f. 12; lvi., f. 16) differs from that of *T. fasciata* in the development of a comparatively thick sphincter (*sp.*) round the atrial end. The aperture does not lead directly into the atrial cavity, but into a small chamber cut off from the latter by a circlet of papillae (*pp*) across which, from side to side, usually stretches a thin structureless membrane, sometimes double, obviously the product of the secretion of unicellular glands situated round its periphery. The chamber thus cut off may be regarded as a specialised part of the ootype or oviduct (metraterm of Ward and of Monticelli) or a separated-off part of the atrium.

In two cases of specimens of this species cut into sections, the occurrence of self-impregnation is suggested. In one of these the end of the penis is advanced into the right-hand corner of the atrium, close to the opening into the ootype. In the other (Plate lvi., fig. 16) the terminal enlarged introvert, with its bristling spines, has passed in further, and is firmly held by the sphincter. There is no proof in these cases that self-impregnation occurs, but the second seems to afford evidence that the function of the sphincter is to hold the penis, whether of the same or another individual, during the act of discharge of the spermatophores.

The dilatations at the ends of the ducts of the shell-glands in the wall of the ootype are very conspicuous, and project as papillae into the lumen. These are arranged in regular longitudinal rows. The cavity of the ootype was found to contain several spermatophores in each of the specimens sectioned, with the exception of one in which there is an egg lodged in the atrium. Spermatophores lie also in the oviduct. There they seem to burst, setting free the spermatozoa, which pass in large sheaf-like bundles into the cavity of the reservoir. The latter is partly divided by a septum (*sp.*) formed of an ingrowth of the syncytium, into a smaller posterior or basal part into which the duct opens, and a larger anterior part. The contents of the former are only, or almost only, normal-looking spermatozoa, while those of the latter are the same mixture of effete reproductive products as in *T. fasciata* with the addition of irregular shreds and fragments which are obviously the remnants of the envelopes of ruptured spermatophores. A mouth-piece and minor receptacles are entirely absent.

In *T. simulator* * the entire reproductive system closely resembles that of *T. comes*: similar spermatophores are formed in the posterior testes and are found distributed in a similar way in the oötype, oviduct and reservoir. But (1) the sphincter at the mouth of the ootype is by no means so specially developed; (2) the ring of papillae on the atrial side of this aperture is absent; (3) the terminal enlargements of the shell-gland-ducts are not arranged in longitudinal rows. In the neighbourhood of the opening of the ootype into the atrium some of the papillae assume the appearance of rudimentary teeth.

C. Description of the parts in T. novae-zelandiae.

T. novae-zelandiae differs in a very marked manner from the other Australasian species, and most of the distinctive features are connected with the female reproductive apparatus (Plate lv., fig. 11). This has been described by Merton (1914); but it is desirable to give here a résumé of the main facts for the purpose of comparison, and to add certain points not hitherto recognised. The most striking feature is the development of the posterior region of the ootype (*mm*) into a muscular bulb containing a system of formidable chitinous teeth. This has no equivalent, so far as is known, in any other member of the order. The "bursa copulatrix" of *Actinodactylella* is a similar structure, but is not a modification of a part of the ootype, being an independent outgrowth from the atrium. Perhaps the vagina of *T. novae-zelandiae* is best looked upon as an enormous extension of the thick sphincter of *T. comes* and the metraterm which it subtends. The atrial aperture of the female duct leads into a narrow passage with thick muscular walls which runs nearly vertically upwards (dorsad). The interior is beset with numerous sharp sub-triangular teeth. Dorsally it enlarges into a muscular bulb the greater part of the thickness of which is composed of circularly running fibres forming a thick hoop. The lumen of this bulbous portion of the ootype, wider than that of the preceding part, is beset with rows of sharp teeth, larger and evidently more highly chitinized than those just referred to. Perforating the thick muscular wall are numerous ducts of the shell-glands, which, as in other species, form a zone round about. These ducts, which present dilatations as in *T. fasciata*, are most clearly traceable in young specimens, in which the teeth are not fully developed or not completely chitinised. Dorsally the bulb opens into the ootype proper. This, which is much smaller relatively than in *T. fasciata*, is a thin-walled chamber of irregular shape surrounded by shell-glands the ducts of which perforate its walls. In the ootype, and extending into the oviduct, is, as in *T. fasciata*, a ridge-like thickening of the epithelial layer running longitudinally and comprising many ducts. It is well represented in Merton's Fig. 47, though not referred to in the text. The oviduct running to the right and dorsad to open into the reservoir, is at first a narrow tube with a few shell-glands opening into it: in the immediate neighbourhood of the reservoir the lumen enlarges, and the wall becomes thickened by contributions from large special myoblasts as in *T. fasciata*. The lumen dilates in the region from which the funnel-like germiduct is given off. From the dilated region, which usually contains a number of spermatozoa, are given off there diverticula

**T. simulator* is the name which I propose to apply to an undescribed brown six-tentacled *Temnocephala* occurring with two other species on the Crayfishes of Barrengarry Creek, above Belmore Falls. It is referred to here as it is the only member of the group known to me resembling *T. comes* in developing spermatophores.

(*r.s*) each about .03 mm. in diameter. These are the *receptacula seminis* discovered by Merton: they lie quite outside the oviduct itself, connected with it by a short narrower part serving as a duct: in the interior, closely coiled up, are always a number of spermatozoa which have apparently the staining reactions of normal active spermatozoa like those in the lumen of the oviduct itself. Into this part opens also, on the dorsal aspect, the short main vitelline duct formed by the union of the main right and left ducts.

The reservoir (*r*) lies distinctly to the right of the middle. The opening into it of the oviduct (become reservoir duct) is situated on a prominence projecting into the cavity of the receptacle. From this projects, as in *T. fasciata,* a tubular mouth-piece (*mp*) which is a prolongation of the cuticle lining the interior of the duct. In *T. novae-zelandiae* this is an extremely delicate structure, invariably more or less broken in sections, and were it not for my knowledge of the condition in *T. fasciata* I should have failed to interpret the structure.

Merton (1914) gives excellent figures of series of sections of the female apparatus in *T. novae-zelandiae,* but does not represent the actual opening of the duct into the reservoir. In his fig. 47K *vres* points, not to the cavity of the large reservoir, but to the dilated part of the duct into which the three small "receptacula seminis," the germiduct and vitello-duct all open, and from which the narrow terminal part of the duct, with its slender mouth-piece, leads into the extreme dorsal and right-hand recess of the reservoir.

D. Description of the parts in T. brevicornis.*

In *T. brevicornis* Monticelli the cuticle of the ootype is rather thick and the wall is folded longitudinally so that an appearance of teeth is produced in sections cutting the organ transversely. Merton (1914, p. 47) erroneously ascribed to Monticelli the statement that teeth are present, whereas the latter quite emphatically states that they are absent (1898, p. 86).

The ootype has in its posterior (atrial) portion a thick muscular wall with a small lumen. This persists throughout the vertical part, so that series of horizontal sections present the same appearance from the atrium to the point where the passage changes its direction to run towards the receptaculum and germarium. Here the wall becomes thinner and the lumen wider.

As described and figured by Monticelli (1898, Tav. iv., fig. 19, d) there is a small compartment (metraterm) separated off from the ootype at the atrial end by a sphincter. This closely resembles the corresponding compartment in *T. comes,* but is divided from the atrial cavity, not by a ring of papillae, but by a circular fold with an irregular edge.

Merton's receptacula seminis, five in number, surround the reservoir duct or oviduct in a ring, but are here empty. They are imbedded in the muscular wall of the duct almost as completely as in the case of *T. fasciata.*

The right and left main vitelline ducts meet to open into the oviduct close to the Merton's receptacula and the germiduct, immediately posterior to the former.

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*I am indebted to my friend and former colleague, Prof. J. P. Hill, F.R.S., for my specimens of this species, which are labelled by him "Temnocephala from Fresh Water Tortoise *(Hydromedusa maximiliana)* loc. Theresopolis, Brazil. Oct. 13. Picronitric-osmic acid."

The receptaculum has an incomplete partition. The lumen is very small in four sectioned specimens and is empty or nearly so. The partition separates off the part from which the duct opens from the anterior part. The latter has a very thin anterior wall and, owing to thinness of the intestinal wall in this position, the entire thickness of solid tissue between the lumen of the reservoir and that of the intestine is very small. In one of the series a rupture has taken place in this and part of the reservoir lies in the actual lumen of the intestine as a long narrow process in front of the anterior end of which is a clump of darkly stained matter which may be the discharged contents.

The myoblasts of the reservoir duct are in this species closely amalgamated with the syncytium of the reservoir, nearly completely surrounding the latter as a layer composed of ten or twelve large cells with large nuclei, the cytoplasm not sharply marked off from that of the syncytium, but distinguishable in the stained sections on account of the stronger affinity of the latter for haematoxylin. A quite unique feature is that the investment of muscle lies outside the layer of myoblasts, not inside. I have failed to find any nuclei in the syncytium.

II. RECEPTACULA SEMINIS IN TEMNOCEPHALOIDS.

The vesicle which, in the preceding account of the female reproductive apparatus, I have, in order to avoid implications as to its function, referred to simply as *reservoir* was termed originally *receptaculum seminis* by Weber (1889) and by myself (1888)—the contents being supposed to consist solely or mainly of spermatozoa. More detailed examination, however, showed me a preponderance of yolk material in many cases, and, accordingly, I suggested (1900) the name of *receptaculum vitelli* on the supposition that it acted as a storehouse in which yolk-cells accumulated until they were required for the building up of an egg. Later again (1909) I recognised that the spermatozoa and the yolk-matter contained in the receptaculum are for the most part dead or moribund: the spermatozoa move feebly if at all; what is more conclusive, the yolk-cells have lost their nuclei and are fused together. The receptaculum acts in fact as a storehouse for surplus reproductive material—shell-gland secretion as well as spermatozoa and yolk. I assumed at this time that the accumulation of surplus matter was discharged at intervals through the ootype and genital atrium, to reach the exterior through the genital aperture; and I supposed that the need for a reservoir for this surplus matter was created by the occasional blocking up of the passage by an egg. Merton (1914) confirms my conclusion as to the condition of the contained spermatozoa and regards the receptaculum as an organ in which all superfluous products of the reproductive system are stored to become dissolved and re-absorbed: he proposes for it therefore the name of *vesicula resorbiens*.

The vesicle in question varies considerably in different species of *Temnocephala* and the allied genera; but certain structural features which it possesses in all cases seem to me to be little in agreement with the resorptive function ascribed to it by Merton. In all cases, in addition to an investment of muscular fibres, the wall is composed of a comparatively thin, almost structureless syncytium. Through the protoplasm are distributed large nuclei, 0.02 mm. in diameter in *T. fasciata*, twice as large in *T. quadricornis*. These occur at wide intervals so that many sections of ordinary thickness (5 to 10μ) through the entire length or breadth of the organ contain none. Altogether there are on an

average about 25 in the wall of an organ which may be half or three-quarters of a millimetre in diameter. The syncytium is usually structureless throughout in the best-fixed series. In some specimens of *T. novae-zelandiae,* vacuoles of various sizes, some spherical, others drawn out, appear in the substance of the syncytium, but similar vacuoles appear also in the contents, and I have not been able to ascribe any special significance to them.

This structureless syncytium, with its very infrequent nuclei, would appear to be little adapted to the function of digesting and absorbing such solid or semi-solid matters as spermatozoa, yolk and shell-gland secretion.

At the same time, more thorough examination of the structure of the vesicle, and more especially of its mode of communication with the duct, has shown me that the original theory—viz., that of discharge of the contents through the ootype to the exterior, is untenable. It is obvious that the extremely slender pipe or mouth-piece cannot well be the passage through which the mass of effete reproductive matter which has accumulated in the receptacle becomes discharged. *T. fasciata, T. tasmanica* and *T. novae-zelandiae* are the only species I have studied in which the mouth-piece is actually demonstrable (though there are pretty definite indications of it in some of the other smaller forms): but the essentials are the same in all, and it seems unlikely that the mode of functioning of the vesicle, so clearly circumscribed in the case of *T. fasciata,* can be radically different in the other closely-allied species.

A receptacle corresponding exactly with the reservoir occurring in the Temnocephaloids is of rare occurrence in the Trematodes so far as known. *Distomum variegatum* (Looss, 1894) is one of the exceptions, and in certain other species of the same genus such a reservoir—a "receptaculum seminis" containing other elements besides sperms—co-exists with a Laurer's canal. In *Aspidogaster* the "receptaculum vitelli" is a similar structure (Goto, 1894, p. 169).

In the *Malacocotylea* its equivalent, probably functionally as well as morphologically, is Laurer's canal: in the Heterocotylea the single genito-intestinal canal (Goto). But in some Rhabdocoeles (*Vorticidae*) there is a receptacle which is very similar in structure, relations, and contents to that of the Temnocephaloids.

In the case of all these modifications it may be assumed that the special function of the part is to dispose of surplus reproductive material. In the internal parasites this surplus is presumably not of great importance in connection with nutrition, and may be entirely discarded by being discharged externally through Laurer's canal or through the oviduct: but in the non-parasites or ecto-parasites, the genito-intestinal canal* may provide for its conservation and further use in nutrition.

In the Temnocephaloids there is no permanent genito-intestinal canal, while the arrangement of the parts is such as to facilitate the passage of the effete reproductive material into the reservoir and impede its outward passage through the oviduct. But there are indications that, at intervals, when the reservoir becomes distended, it grows into the lumen of the intestine, forming a passage—a *temporary genito-intestinal canal*—which ruptures at its free end and discharges the contents. The duration of this canal must be brief, since, leaving out of account the specimen of *T. brevicornis* referred to on page 515, I have found it

* In certain Triclads, a Rhabdocoele, and at least one Polyclad.

actually present in two only of the many specimens of *Temnocephala*, serial sections of which I have examined.

One of these series is of a specimen of the Tasmanian *T. tasmanica* (Pl. lvi., figs. 18-21). In this the reservoir has burst into the intestine, and the contents, sharply differentiated by the effects of the staining which the series has undergone, lie partly in the intestinal lumen, partly in the improvised genito-intestinal canal (*gi*). The other is one of a specimen of one of the largest and most complex species—*T. quadricornis*. Here (fig. 22) a comparatively long diverticulum has been developed from the receptaculum and opens terminally into the intestine—portions of the contents being traceable throughout the length of the temporary genito-intestinal canal. Here we seem to have a temporary condition comparable with what is permanent in *Hexacotyle grossa* (Goto, 1894, p. 221).

In *T. semperi* and *T. novae-zelandiae* Merton observed such a condition in several instances:—

Sowohl bei *T. semperi* als bei *novae zelandiae* fand ich Exemplare bei denen das Blasen-lumen in dem Darm geöffnet war. Dass dies erst bei der Konservierung durch platzen der Blase erfolgte, scheint möglich. Es wäre aber auch denkbar, das bei den nahen Beziehungen der Blase zum Darm dieser Fall auch im Leben eintritt, wenn die Blase überfüllt wird, wie es bei dem receptaculum seminis einiger Trematoden beobachtet worden ist" (p. 42).

To the two cases described above, I may add a third. In this, however, the genito-intestinal connection is incomplete. The canal (fig. 17, *gi.*) is represented only by a clean-cut cylindrical channel which runs from the lumen of the reservoir (into which it opens directly) forwards through the syncytium (here specially thickened) to terminate abruptly against the enclosing layer of muscular fibres. In this canal, and in smaller spaces round about which may be branches from it, are many spermatozoa and minute clumps of granular matter.

It appears probable that we have here either the rudiments or the vestiges of a genito-intestinal canal, and the former rather than the latter, since the contained spermatozoa are less altered than those in the main cavity of the reservoir itself.

That the cases which I have observed are due to bursting in the process of fixation seems to me very improbable. The appearance presented by the specimens of *T. quadricornis* and *T. tasmanica* described is hardly reconcilable with such a conclusion.

Merton's receptacula seminis occur in all the species I have examined for them except *T. comes* and *T. simulator*. The chief difficulty in my opinion in the way of accepting Merton's view as to the function of these bodies is their small size. In *T. fasciata* each is only, at most, about .03 mm. in diameter, the enclosed ball of spermatozoa contracting to about .02 mm. in sections. In *T. novae-zelandiae* the size is about the same—a little greater in relation to the size of the animal. In the former species the living spermatozoon is at least .2 mm. in length, so that it would need to be very closely coiled up to be packed into the space, and only a small number can be received.*

*I take the opportunity of correcting here an error which Merton makes regarding my account of the spermatozoa. He states (p. 37), "Nach Haswell sollen am Hinterende des Kopfes zwei lange Cilien sitzen, die, mehrmals so lang sind als das ganze Spermatozoon." This is not correct. On page 120 I give the total length of the living spermatozoon in *T. fasciata* as .2 mm. and that of the cilia as .015 mm. Moreover I figure the living spermatozoon with its cilia (fig. 12, Plate xiii.).

The little knot of spermatozoa in each vesicle stains strongly with haematoxylin so as to be comparable with the sperm-masses in the vesicula seminalis in the same section or same series. But in this respect there is little to distinguish them from some of the scattered spermatozoa in the contents of the reservoir. Their main feature is their closely-coiled state which does not seem to be very favourable to their supposed fate of being passed out into the oviduct to fertilize emerging ova. Moreover, differential staining sometimes reveals the presence of other bodies besides spermatozoa in the contents of these vesicles. Taking all these things into account, I think it improbable that these are receptacula seminis in the sense of receptacles in which spermatozoa are received in copulation in order to fertilize the ova as they pass out from the ovary. At the same time the absence of these vesicles in the only two species developing spermatophores seems to favour Merton's view.

Summary.

The vesicle variously known as receptaculum seminis, receptaculum vitelli and vesicula resorbiens has a duct which opens into it in some species of *Temnocephala*, probably the majority, by a slender chitinous tube or mouthpiece, the arrangement being such as to render the evacuation of the contents of the vesicle (reservoir) through the oviduct and atrium an impossibility.

The discharge of these contents (surplus reproductive material) appears to take place by the formation of a temporary connection with the intestine (temporary genito-intestinal canal) of very short duration.

The small diverticula of the oviduct discovered by Merton and regarded by him as receptacula seminis are present in all the species examined, with the exception of two in which fertilization is effected through the agency of spermatophores.

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EXPLANATION OF PLATES LIV.-LVI.

Lettering.

a. atrium; *aa.* atrial aperture; *ag.* atrial glands or their ducts; *c.* capsule enclosing reproductive apparatus; *g.* germarium; *gd.* germiduct; *gi.* genito-intestinal canal (temporary); *i.* intestine; *ie.* epithelium of intestine; *m.* myoblasts of female duct; *mm.* metraterm; *mp.* mouth-piece of duct of reservoir; *mr.* muscle of wall of reservoir; *nr.* nucleus of syncytium of reservoir; *od.* oviduct; *p.* penis; *ph.* pharynx; *pp.* papillae of circle round female aperture into atrial cavity; *r.* cavity of reservoir; *rd.* duct of reservoir; *rs.* Merton's receptacula seminis; *s.* sucker; *sc.* syncytium of reservoir; *se.* septum in reservoir; *sg.* shell-glands; *sgd.* shell-gland ducts; *sp.* sphincter; *spt.* spermatophore; *sr.* syncytium of reservoir; *t.* testis; *u.* uterus; *vd.* vitelline duct; *vdl.* left vitelline duct; *vdm.* main vitelline duct; *vdr.* right vitelline duct; *x.* mass of surplus reproductive matter in reservoir.

Plate liv.

Figs. 1 to 6. Corresponding portions of successive sections from a thick horizontal series of *Temnocephala fasciata* showing the relations of the parts in the region of the mouth-piece in ventro-dorsal order. (× 205).

Fig. 1 shows parts of the mouth-piece (*mp*) in the syncytium (*sr.*) of the reservoir (*r*) in which one nucleus appears, myoblasts (*m*) and portions of shell-glands (oviducal glands).

Fig. 2 shows slightly displaced parts of the mouth-piece embedded in the syncytium with the beginnings of the terminal part of the muscular wall of the duct and the oviduct in cross section.

Fig. 3 shows the free end of the mouth-piece with its opening into the cavity of the reservoir.

Fig. 4 shows oblique section through muscular thickening of duct at base of mouth-piece.

Fig. 5 shows two of Merton's receptacula seminis (*rs.*) and beginning of germarium (*g.*).

Fig. 6 shows transition of reservoir duct (*rd.*) into oviduct (*od.*) with Merton's receptacula seminis.

Fig. 7. *T. fasciata.* End of mouth-piece, from another horizontal series. (× 440).

Plate lv.

Fig. 8. *Temnocephala fasciata*. Diagrammatic lateral view of the female part of the reproductive apparatus (× 50). The vitelline glands and ducts are not shown and only two of the myoblasts are indicated.

Fig. 9. *T. fasciata*. Diagrammatic ventral view of the female part of the reproductive apparatus. The vitelline ducts and the germiduct are not represented.

Fig. 10. *T. fasciata*. Portion of a horizontal section showing the mouthpiece of the reservoir with its connections. (× 205).

Fig. 11. *T. novae-zelandiae*. Diagrammatic ventral view of the female part of the reproductive apparatus. The myoblasts are not shown.

Fig. 12. *Temnocephala comes*. Diagrammatic ventral view of the female part of the reproductive apparatus. The germiduct and vitelline duct are not represented.

Plate lvi.

Figs. 13 to 15. *T. fasciata*. Corresponding portions of three consecutive sections of a thick (about 12μ) horizontal series cut in ventral-dorsal order. (× 205).

Fig. 13. Section on the dorsal side of the reservoir, passing through the thickened terminal part of the reservoir duct (*rd.*) showing sections of four of the "receptacula seminis" (*rs.*) buried in the muscular wall; the right and left vitelline ducts (*rvd., lvd.*) converging and the former just passing through the enclosing capsule (*c.*) of the female reproductive apparatus.

Fig. 14. Nearer convergence of the vitelline ducts: appearance of germarium (*g.*).

Fig. 15. Union of vitelline ducts in short median duct (*mvd.*) opening into the oviduct.

Fig. 16. *T. comes*. Portion of a section from a horizontal series, showing the opening of the uterus into the atrium with the sphincter (*sp.*) and the ring of papillae (*pp.*). The position of the end of the penis (*p.*) roughly indicated. (× 150).

Fig. 17. *T. fasciata*. Portion of a section from a horizontal series, showing what appears to be a rudiment (or a vestige) of a genito-intestinal canal (*gi.*).

Figs. 18 and 19. *T. tasmanica*. Two successive longitudinal and vertical sections of a specimen with a communication (genito-intestinal canal) (*gi.*) between the reservoir and the intestine. (× 50).

Figs. 20 and 21. Portions of the sections represented in Figs. 18 and 19, showing the reservoir (*r.*) and its connections. (× 205).

Fig. 22. *T. quadricornis*. Diagram of the genito-intestinal canal. From six sections of a horizontal series.

AUSTRALIAN COLEOPTERA: NOTES AND NEW SPECIES. No. iv.

By H. J. Carter, B.A., F.E.S.

(Thirteen Text-figures.)

[Read 29th October, 1924.]

The following notes are the outcome of an examination of some unnamed Buprestidae belonging to various Australian Museums and of Tenebrionidae and Cistelidae sent by entomological friends. Two new genera are described and some interesting new species from an interesting faunal region, Stanthorpe—a granitic highland of South Queensland—sent by Messrs. F. A. Perkins and R. Illidge.

Further corrigenda to my "Revision of Stigmodera."

S. (*Castiarina*) *crenata* Don. In my "Revision" I followed Castelnau and Gory's erroneous determination of this species, and again erred in my identification of these authors' *S. plagiata* with a species that I now consider to be undescribed. A further confusion of names has been caused by the fact that, in the monograph referred to, the species described in the text as *sexplagiata* is figured as *plagiata*.

The only *Castiarina* that corresponds with Donovan's figure (Epit. Ins. N. Holl., f. 3)—his description is useless—is *amphichroa* Boisd. Hence the following corrections are necessary in my tabulation:—

No. 342. Light bands of elytra red, apices widely lunate, external spine long .. .. *kershawi*, n.sp.

No. 343. Light bands of elytra orange—laterally sanguineous—apices finely lunate, shortly bispinose .. .. *sexplagiata* C. & G.

The synonymy (p. 87 of my Revision) should now read:

S. crenata Don. = *amphichroa* Boisd. = *sexspilota* C. & G. = *sieboldi* C. & G.

S. cylindracea Saund. = *bucolica* Kerr. (The latter, a distinct species, was erroneously placed as a synonym of *amphichroa* Boisd.).

S. sexplagiata C. & G. = *plagiata* C. & G. = *crenata* C. & G. (*nec* Don.) = *bicruciata* Hope = *hopei* Boh. = *similata* Boh. = *kreffti* Macl. = *variata* Kerr.

(This is probably the commonest species in the genus and generally labelled in collections *S. crenata* Don.).

S. erythromelas Boisd. In my tabulation, *S. cyanipes* Saund. and *S. erythromelas* Boisd. should be interchanged, so that *cyanipes* should appear as No. 304 and *erythromelas* as 305, with its synonyms *armata* Thoms. and *longula* Blkb. The following is the description of the new species referred to above.

STIGMODERA (CASTIARINA) KERSHAWI, n.sp.

Lightly obovate. Head greenish, mouth blue, pronotum and scutellum black or blue-black, underside and legs blue; elytra brick red with a narrow basal band, the suture, two fasciae and a quadrilateral apical spot blue-black, the premedial fascia lunate, not extending to the sides, the postmedial fascia wider than the former, widened at the suture and extending to the sides.

Head widely excavated between eyes, punctate. *Prothorax* lightly bisinuate at apex, strongly so at base, sides well rounded, widest behind middle, all angles a little produced, disc moderately convex, with round, well-defined punctures (considerably larger and less dense than in *sexplagiata* C. & G.), medial channel in general lightly indicated, frequently obsolete at middle. *Elytra* wider than prothorax, widest behind middle, sides lightly constricted behind humeral swelling, apex with a moderately large semicircular lunation, the external spine rather long, the sutural spine sub-obsolete, posterior margins minutely serrated: striate-punctate, the interstices lightly convex and closely punctate, the 2nd and 4th wider and more raised than the rest. Underside lightly punctate, very shortly and sparsely pubescent. *Dimensions*: 10-12 x 4-4.5 mm.

Habitat.—Victoria: Warburton (Mr. J. E. Dixon and the author); N.S. Wales: Mountain districts, Jenolan, etc.

Ten examples are now before me. This is the species (No. 342 of my tabulation) erroneously determined as *plagiata* C. & G. which should be known as *sexplagiata*. Though closely allied to this species, the following comparison shows very clear separating characters, especially in the form and sculpture of the pronotum, and the very different elytral apex.

Dedicated to Mr. J. Kershaw of the National Museum, Melbourne. Type in Coll. Carter.

	sexplagiata C. & G.	*kershawi*, n.sp.
Colour		
Pronotum.	green or greenish-black.	black or blue-black.
Underside.	green-bronze.	peacock-blue.
Elytra.	ground colour orange, sanguineous at sides, premedial fascia often broken up into spots.	uniformly brick-red, premedial fascia seldom (if ever) broken up into spots.
Structure		
Eyes.	closer.	wider apart.
Pronotum.	densely, finely and uniformly punctate, gibbous, with deep, well-defined medial sulcus.	punctures larger and not uniformly placed, not gibbous, medial sulcus seldom clearly defined.
Elytra.	apical lunation small, formed by oblique excisions between ill-defined spines.	apical lunation much larger, forming a semicircular excision, the exterior spines well-defined.

BUPRESTIDAE.

Chalcotaenia quadri-impressa Waterh. = *C. finitima* Obenb.

An example of Obenberger's species labelled "compared with type," sent by Mons. Théry, is indistinguishable from the well known *C. 4-impressa* Waterh.

Endelus subcornutus Kerremans. I have identified a specimen of this in the Macleay Museum, labelled Cape York. It was described as from New Guinea, and is the first recorded species of the genus from Australia.

Castalia bimaculata L. = *Polycesta mastersi* Macl. I have little doubt as to the correctness of this synonymy which a comparison of Macleay's type with the figure of Linnaeus's species in Laporte and Gory's Monograph, as also in Saunders's Revision (1868), substantiates. Macleay's brief description of the elytra of *Polycesta mastersi* is misleading "Elytra coarsely striato-punctate," since the elytra have the alternate intervals carinate-costate, while the apices are multispinose. No reference is made to the lightly marked "maculae," seen in some of the specimens, though often evanescent in old examples.

CASTALIA SCINTILLANS, n.sp. (Text-fig. 1.)

Elongate, oblong, dull metallic reddish-brown above and below, including legs and antennae.

Head scarcely, or feebly convex, eyes rather prominent; coarsely rugose punctate, with elongate, raised, medial impression; antennae short, segments 5-11 very slightly and obtusely dentate. *Prothorax* convex, apex nearly straight (lightly advanced at anterior angles), base bisinuate; sides rounded, hind angles subrectangular; disc subconfluently alveolate-punctate, the edges of punctures raised, the base of each with a brilliant metallic spot; medial sulcus distinct, some reticulate rugosity at sides, extreme margins reflexed. *Scutellum* small, rounded. *Elytra* of same width as prothorax at base and more than thrice as long; subparallel, widening at shoulders, margins faintly crenulate behind, apices trispinose, the short teeth forming the terminals of the costae; alveolate-punctate, the punctures more or less seriate and with metallic scintillation as on pronotum; the alternate intervals forming slightly crenulate costae, the 2nd and 4th more strongly raised than the rest; suture also raised; pro-, meso- and metasternum coarsely punctate, abdomen with irregular elongate punctate impressions with smooth interspaces, the first segment sulcate. *Dimensions*: 14 x 5 mm.

Habitat.—Western Australia: Kellerberrin (W. Duboulay).

Two examples from the National Museum, Melbourne, though in outline and convexity like *Microcastalia globithorax* Thoms., cannot, I think, be generically separated from *Castalia bimaculata* L., from which it differs as follows:—colour a lighter shade of bronze, without any sign of the dark fasciae sometimes seen in *bimaculata;* in form, narrower, more elongate and depressed, the punctures of pronotum much denser, the elytral costae wider and less clearly defined, apices of elytra without the many small spines seen in *bimaculata,* while the scintillating base of punctures is a noticeable character that extends to the femora.

From *Microcastalia globithorax* Thoms. (= *Bubastodes sulcicollis* Blackb.) it differs in colour, in the much rougher sculpture, and the more pronounced elytral costae, *inter alia.* Type in the National Museum, Melbourne.

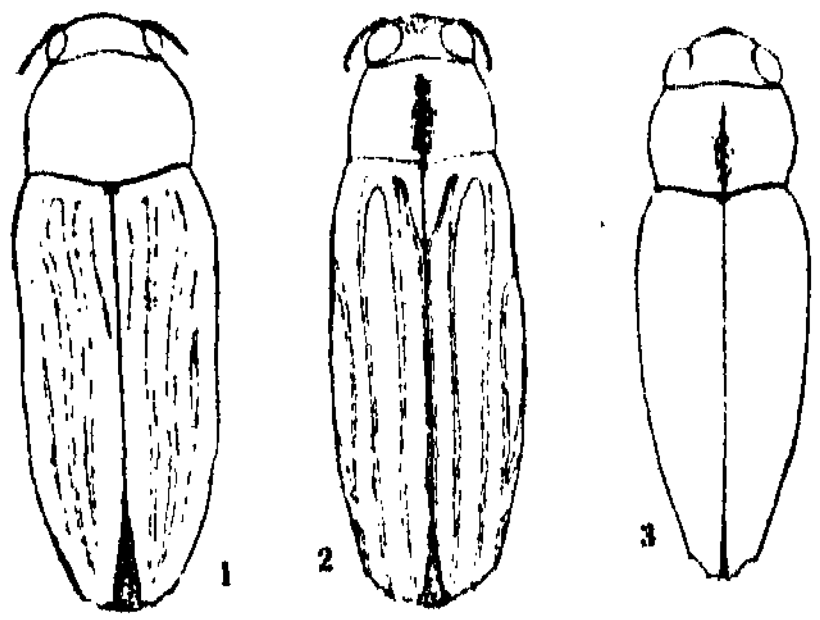
Two examples of *Castalia bimaculata* L. are before me, a male from Blackall (Q.) measuring 15 x 6 mm. and a female from the National Museum, from Rockhampton, measuring 21 x 7½ mm.

NEOBUPRESTIS ALBOSPARSA, n.sp. (Text-fig. 2.)

Elongate-oblong, moderately flat; head and pronotum dull black with violet reflections, elytra dull blue-black, with a few small white pubescent spots arranged more or less in transverse lines, one on each interval near base, about 12 in a premedial line, about 8 in each of two equally-spaced postmedial lines and about 8 close to apex, besides one or two of irregular position; underside glabrous,

brilliantly metallic, dark green or blue, with the apical segment and margins of other segments of abdomen violet; antennae, legs and tarsi blue.

Head flat, rugose-punctate, with short sparse pubescence, feebly sulcate between the eyes, with a smooth medial carina in front; eyes large and prominent. *Prothorax* slightly narrower than head; apex and base subtruncate, sides very lightly arched and feebly converging to apex; deeply and widely sulcate in middle, anterior angles acute, posterior rectangular, disc rugose-punctate with some large irregular depressions. *Scutellum* small, circular, impressed in middle. *Elytra* much wider than prothorax and three and one-third times as long; each with



1. *Castalia scintillans.* 2. *Neobuprestis albosparsa.* 3. *Notobubastes costatus.*

six well-marked costae (including the raised suture and marginal borders), besides a short scutellary costa, the interspaces reticulate-punctate; the apices multi-spinose, the spines small. Sternal area with large round punctures, abdomen with longitudinal pear-shaped punctures, the first segment sulcate, the apical segment bispinose, a pubescent spot at side of each segment. Hind tarsi with basal joint as long as 2nd and 3rd combined. *Dimensions*: 13 x 5½ mm.

Habitat.—Cairns, N. Queensland (Allen).

A single male specimen in Mr. Lea's collection is very like *N. marmorata* Blackburn (of which a female from Victoria is before me) in form, but differs markedly in (1) colour, the large yellow fasciate blotches of Blackburn's species being replaced by very small pubescent spots, (2) the intercostal spaces of elytra more coarsely punctate, (3) underside more brilliant. Type in Coll. Lea. There are also two examples in the Macleay Museum, one labelled Richmond (presumably Richmond River, N.S.W.), the other labelled Victoria, in which the pubescent spots are much abraded.

N.B.—Probably *N. marmorata* Blkb. and *N. albosparsa* should be generically separated from *N. frenchi* Blkb. and *N. australis* Blkb., the less prominent eyes, the more sinuate apex of pronotum, the less elongate elytra with non-spinose apices, the first abdominal segment not sulcate in the case of the two last suggesting differentiation, but with the scanty material available they may for the present remain as in the "Genera Insectorum."

PSEUDANILARA BICOLOR, n.sp.

Depressed, subparallel; head, antennae and prothorax indigo-blue, the last with front margins violet; elytra coppery-brown, subnitid, underside and legs violet.

Head densely and finely punctate, clothed with long whitish hair; eyes large, prominent, converging behind; antennae with segment 1 as long as 2-3 combined, 3 longer than 2, subdentate; 4-11 triangular with short internal tooth. *Prothorax* convex and transverse, bisinuate at apex and base, the former lightly produced in middle and at angles, the latter widely lobate in middle and sub-falcate at posterior angles; sides well rounded, widest near base, considerably narrower at apex (here slightly narrower than head) than at base; all angles acute; disc densely and strongly punctured, setose at sides and apex, without foveae or medial line. *Scutellum* circular, moderately large. *Elytra* rather wider than prothorax at base, shoulders rounded; subparallel for the greater part, separately rounded at apex, apices not quite covering abdomen, leaving an exposed coarsely punctate pygidium; hind margins denticulate; disc densely and finely punctate with some feebly indicated longitudinal impressions; underside rather densely punctate with a short white pubescence. *Dimensions*: 7 x 2.5 mm.

Habitat.—Queensland, Bowen (A. Simson).

A single specimen from the South Australian Museum is a puzzling species to classify. The wide head and strongly bisinuate base of pronotum give it a strong likeness to *Melanophila cupripes* Macl., but the first two abdominal segments are soldered and the elytra do not quite cover the abdomen. *P. roberti* Théry has the abdomen completely covered by the elytra, but I am doing less violence to generic limits by placing it here than in *Anilara, Melanophila* or *Neocuris,* the bisinuate base of pronotum placing it outside the first and the soldered basal segments of abdomen outside the two latter. Type in S. Australian Museum.

Pseudanilara roberti Théry.—I have determined 4 examples of this taken near Sydney (two by myself and two by Mr. Erasmus Wilson). The type was described from Victoria. A specimen in the Macleay Museum is labelled Port Denison, Q'land. (Since writing the above I have received the type, very courteously sent for examination by the author. This confirms my determination. Further a comparison of this type with that of *Anthaxia purpureicollis* Macl. fails to show any specific distinction, while *Anthaxia nigra* Macl. differs only in its black surface and slightly smaller size. Thus *Pseudanilara* (*Anthaxia*) *purpureicollis* Macl. = *P. roberti* Théry, var. *nigra* Macl.

PSEUDANILARA OCCIDENTALIS, n.sp.

Oblong, abruptly attenuated behind; head and pronotum blue, suffused with purple, the latter colour especially at sides and base of prothorax; elytra bluish-green, legs and underside purple, abdomen here and there greenish.

Head wider than apex of prothorax, eyes subparallel, the inner margins slightly converging to the vertex, surface punctate and pubescent. *Prothorax*: apex feebly advanced in middle and at sides, base strongly bisinuate, sides obliquely diverging from apex to near base, then abruptly and roundly narrowed, hind angles acute and subfalcate; disc finely and densely alveolate-punctate, more strongly at sides and base. *Scutellum* minute and circular. *Elytra* clearly narrower than base of prothorax, subparallel to near apex, apices separately rounded, margins finely serrate for the greater part; a wide ridge following the basal outline, accentuated by sulcate depression behind it, disc closely shagreened, the sculpture (under a Zeiss binocular) shown to consist chiefly of fine transverse ridges. The suture between the 1st and 2nd abdominal segments almost

invisible; basal margin of metasternum with four short spines, two on each side at the angles; prosternum with fine, dense punctures, abdomen subglabrous and nitid, with uneven shallow punctures. *Dimensions*: 7 x 3 mm.

Habitat.—Western Australia (South Australian Museum).

A single example can be readily distinguished, apart from colour, by the subfalcate basal angles of the pronotum, the elytral basal ridge, and the spinose metasternum. Type in South Australian Museum.

Neotorresita.—This genus has recently been published by Dr. Obenberger (Sbornik Ent. Mus. Prague, 1923, p. 19) for the reception of a species that is clearly identical with that much described species *Melanophila* (*Anthaxia*) *cupripes* Macl., referred to by me (Ent. Soc. Lond., 1923, p. 104). Since then I have been able to study the palaearctic genus *Melanophila* and am now satisfied that the above species is a *Pseudanilara*. Dr. Obenberger also gives six characters in which his genus differs from *Melanophila*. The following synonymy thus shows an insect that has been referred to six different genera: *Pseudanilara* (*Anthaxia*) *cupripes* Macl. = *Melanophila* (*Melobasis*) *laticeps* Kerr. = *M. australasiae* Kerr. = *Neocuris dilaticollis* Blkb. = *Neotorresita achardi* Obenb.

NOTOBUBASTES COSTATUS, n.sp. (Text-fig. 3.)

Elongate ovate, convex; dark violet-bronze, subnitid; head and underside with short pubescence.

Head convex in front, a longitudinal carina between eyes, surface coarsely rugose-punctate; eyes prominent, making head slightly wider than base of prothorax, their inner margins not quite parallel. *Prothorax* convex, apex truncate, base bisinuate, anterior angles obtuse, sides evenly rounded, scarcely sinuate before the acute posterior angles, the lateral carina ill-defined, not visible from above; medial sulcus deep, not quite reaching apex; surface coarsely and rather unevenly punctate, the lateral half coarsely rugose. *Scutellum* small, transversely oval, depressed in middle. *Elytra* wider than prothorax at base, shoulders widely rounded, sides attenuate from middle; apices dehiscent, each shortly but sharply trispinose, the sutural and subsutural spines rather close, enclosing a lunate excision, the lateral spine separated from the second by a sinuate margin, margins entire, each elytron with four well-defined costae, these roundly convex; becoming narrowly carinate at apex; besides a short scutellary costa and the raised suture, the costae sparsely, the intervals strongly punctate; the punctures in the basal area forming crenulations on the sides of the widened costae. Sternal regions, especially the prosternum, densely rugose-punctate, abdomen coarse and (except the anal segment) sparsely punctate, the latter rather squarely rounded behind and densely punctate. *Dimensions*: 12 x 4 mm.

Habitat.—Western Australia: Kookynie (French Coll. in National Museum, Melbourne).

A single female specimen is the only example I have seen of this distinct species. While generically inseparable from my other three species, it is clearly differentiated by outline and elytral sculpture. Type in Melbourne Museum.

Bubastes.—Dr. Jan Obenberger has published recently a Revision of the genus (Ann. Soc. Ent. Fr., 1920, pp. 89-108) and has very courteously supplied me with a copy. Having lately examined a very large number of specimens from the chief museums of Australia with this "Revision" before me, the resulting notes here recorded may interest students of Australian Buprestidae.

Obenberger proposes the name *Bubastini* to include in a group the genera *Bubastes* C. & G., *Euryspilus* Lec., *Neraldus* Théry, *Neurybia* Théry and *Para-*

tassa Mars. (the last found in Africa and unknown to me). I cannot recognize *Neraldus* as distinct from *Bubastes*. A cotype of *N. bostrychoides* Théry, kindly sent me by the author, only differs from typical *Bubastes* in the less prominent eyes. Obenberger tabulates *Neraldus* "d'après leur description" as follows:—"Yeux plus petits, non saillants, réniformes, éloignés du prothorax. La carène latérale du prothorax manque presque complètement. La marge antérieure du prothorax est échancrée."

Of these four characters the first two are true only in degree. Other *Bubastes*, e.g., *achardi* Obenb. and *cylindrica* Macl., approach it as to the small and less salient eyes. The character "éloignés du prothorax" depends somewhat on the position of the head when set. As regards the lateral carina, my example has a defined carina for about halfway from the base, a character shared by *B. globicollis* Thoms., while I cannot find a trace of the fourth character (prothorax échancré). Moreover, I think Obenberger has redescribed *N. bostrychoides* as *Bubastes olivinus*.

In his characterization of the group *Bubastini* there is one notable mistake, the last sentence being "Le sommet des élytres n'est jamais denté en scie latéralement." As a matter of fact every *Bubastes* examined has the hind margins serrated more or less finely. *Euryspilus* and *Neurybia* have minute crenulations.

On the same page he says "Le genre Bubastes . . . . est jusqu'à présent assez mal représenté dans les collections et ses espèces semblent etre relativement rares." This is not the case in Australian collections. In Western Australia some species are very common. I have before me now about 150 examples of the genus, including 35 *laticollis* Blackb., 30 *inconsistans* Thoms., 24 *bostrychoides* etc.

Of the specific characters used by Obenberger, I am unable to follow him in his division into two groups, the one distinguished by "le front bombé," the other by "le front creusé au milieu par une large impression." Belonging to the first group he states that *cylindrica, olivinus, inconsistans* and *sphenoidea* "ont la tete bombée, absolument sans impression marquée." I have before me *cylindrica* (compared with type), *inconsistans* Thoms. (= *inconstans* Blackb., compared with type), *sphenoidea*, also the types of *occidentalis* and *splendens* of Blackburn, and cotypes of *laticollis*. *In no single case* can the head be said to be "without an impression," though it is often confined to a small sulcus at the base of the head, and while some species (e.g., *bostrychoides* and *sphenoidea*) have the front more clearly "bombée" than others, it is only a question of degree, and amongst a series of *bostrychoides* and *inconsistans* I find examples in which the front might be termed "creusée," the difference being in some cases sexual. The genus is difficult to classify owing to the great variability of the common species in size and colour.

As to colour, see Blackburn's description of *B. inconstans* (later considered by him as a synonym of *inconsistans* Thoms.). Blackburn omitted both dimensions and locality for *inconstans* and *laticollis*. I have both species varying from 11 x 3½ mm. to 22 x 8 mm., the larger examples being female. The former I have from N.W. Victoria and South Australia, the latter from Kalgoorlie, Geraldton and other parts of Western Australia. *Bubastodes sulcicollis* Blackb. and *Neobubastes aureocincta* Blackb. should be clearly separated from *Bubastes*, the former being synonymous with *Microcastalia globithorax* Thoms., as suggested by Kerremans (Gen. Ins.), the latter being erroneously merged with *Bubastes* by Kerremans.

The following is my view of the described species of *Bubastes*, with synonymy and localities:—

1. *sphenoidea* C. & G. Cunnamulla, Queensland.
2. *inconsistans* Thoms. = *inconstans* Blackb. = ? *australasiae* Obenb. N.W. Victoria and Quorn, S.A.
3. *globicollis* Thoms. = ? *simillima* Obenb. Nyngan, N.S.W., and Queensland.
4. *cylindrica* Macl. Geraldton, and King Sound, W.A.
5. *laticollis* Blackb. Kalgoorlie, Geraldton, Mullewa, W.A.
6. *vagans* Blackb. N.W. Victoria and S.A.
7. *splendens* Blackb. = *persplendens* Obenb. Tennents' Creek, Fitzroy River.
8. *occidentalis* Blackb. Eucla, S.A. and W.A.
9. *suturalis* Cart. = *strandi* Obenb. Drysdale River, and Cue, N.W.A.
10. *formosa* Cart. Cue, W.A.
11. *bostrychoides* (Neraldus) Théry = *olivinus* Obenb. Perth, Beverley, W.A.
12. *achardi* Obenb. Cobar, N.S.W., Cooktown, Q'land.
13. *niveiventris* Obenb. Cooktown, Rockhampton, Q'land.
14. *obscura* Obenb. Kuranda, Q'land.
15. *aenea* Obenb. N. Q'land.
16. *viridicuprea* Obenb. N. Q'land.
17. *leai*, n.sp. W.A.

There is little doubt of the synonymy of *splendens* and *persplendens*. There is some blunder in Blackburn's dimensions, given as 7 x 2 lines. The type from the National Museum, before me, measures 18½ x 5½ mm., which is almost exactly that of *persplendens* from the same district, while Obenberger's description of the latter accurately fits Blackburn's type, except that the elytra are greenish-blue instead of emerald-green, as the head and pronotum.

Since writing the above I have received a copy of Dr. Obenberger's paper (Arch. fur Naturg., 1922, pp. 64-168) in which he describes six new species of *Bubastes*, besides a so-called subspecies (which I take to be synonymous with *variety*). As elsewhere it seems that this author does not make sufficient allowance for variation. Thus *B. simillima* Obenb. does not, I think, warrant separation from *globicollis* Thoms., in which the eyes—according to 8 examples before me—are in no case so prominent laterally as in the outline figure given on p. 106 of Obenberger's Revision. Again *B. australasiae* Obenb. is only, I consider, a form of *inconsistans* Thoms. Of the remaining four I think I have identified *P. niveiventris* in specimens in the Macleay Museum from Cooktown and Rockhampton, and *P. obscura* in an example from Kuranda sent by Monsieur Théry for determination. *P. aenea* and *P. viridicuprea* I cannot identify at present. Both must be rather close to *occidentalis* Blackb. The evident synonymy of *B. strandi* Obenb. with *B. suturalis* Cart. and of *B. persplendens* Obenb. with *splendens* Blackb. is unnoticed.

BUBASTES LEAI, n.sp.

Elongate, subcylindric, finely attenuate behind; head and pronotum green (in one example bluish-green), moderately nitid, elytra golden-green or coppery, underside brilliantly coppery-green, apical segment violaceous; legs coppery, antennae coppery at base, the rest obscure greenish.

Head (seen from above) convex in two examples, feebly concave in a third, clearly channelled near base of forehead, eyes not prominent (less so in ♂ than in ♀, their inner margins subparallel, interspace about the width of the lateral

diameter of one eye; densely covered with round deep punctures. *Prothorax*: apex and base bisinuate, the former rather strongly produced in middle, widest near front, sides gently widening from base to apical third, then rounded and narrowed to apex, posterior angles acute; punctures as on head, scarcely contiguous in middle, alveolate at sides. *Scutellum* subcircular, laevigate. *Elytra* subconic, apices obliquely bispinose; with densely crowded rows of punctures, the intervals nearly flat and themselves closely punctate except near base. Prosternum coarsely punctate, mesosternum transversely rugose, metasternum and abdomen closely and finely punctate; underside without pubescence. *Dimensions*: 13.5-15 x 4.3-4.6 mm.

Habitat.—Western Australia (South Australian and Macleay Museums).

Three examples examined differ slightly in the colour of the upper surface. What I believe to be the male has the eyes less prominent, the elytral intervals feebly convex with the usual abdominal sexual character (the last segment shorter than elytra and truncate at apex). Only three described species have a bright metallic green or coppery underside, viz., *splendens* Blkb., *occidentalis* Blkb., and *suturalis* Cart. *B. leai* is readily distinguished from these by the much more densely punctate head and pronotum and its duller upper surface. In its surface sculpture and general form it is nearest *B. bostrychoides* Théry (= *B. olivinus* Obenb.). It is not very near the other bicoloured species *B. vagans* Blkb., which has its pronotum less densely punctate, the elytra purple and the underside obscure green. Type in South Australian Museum.

N.B.—*B. splendens* Blkb. and *B. occidentalis* Blkb. The types of these two species are before me. While closely allied I consider them distinct; the former differs not only in the colour of elytra (blue-green in *splendens*, golden-green in *occidentalis*), but in their apical structure and especially in the punctures of the underside, which in *splendens* are unusually fine and sparse, in *occidentalis* strong and close.

EURYSPILUS VIRIDIS, n.sp.

Narrowly cylindric; metallic green throughout.

Head: front depressed and finely canaliculate between the eyes, these rather prominent; finely and densely punctate, antennal joints dentate from the 6th outwards. *Prothorax* cylindric, apex and base subtruncate, sides very slightly converging in a straight line from base to apex, disc finely punctate, showing a slight transverse striolation; medial impression clearly defined throughout except near apex, widened at base. *Scutellum* round, impressed at middle. *Elytra* of same width as prothorax at base, apices feebly bidentate; apical margins minutely serrate, each with the suture and four costae sharply raised, both costae and intervals finely punctate; underside coarsely punctate. *Dimensions*: 9 x 2.2 mm.

Habitat.—Western Australia: Swan River.

A single male example in the Macleay Museum closely resembles *E. chalcodes* C. & G. in form and sculpture. It may be distinguished, however, not only by colour, but by the finer sculpture of its upper surface and the less deeply incised dentation of the apices. The underside is, if anything, more coarsely punctate than in *E. chalcodes*. Type in the Macleay Museum.

Euryspilus australis Blackb.—I have, I think, identified this in several collections (including my own). If this determination is correct Blackburn was mistaken in stating the antennae to be dentate from the 5th joint. A specimen now before me from King George's Sound is clearly dentate only from the 6th

joint as in *E. chalcodes* and *E. viridis*. *E. australis* Blkb. is quite distinct from *E. chalcodes*, of which I expressed a doubt in a former paper (These Proc., 1924, p. 23).

CURIS OBSCURA, n.sp.

Elongate, sharply attenuated behind; upper surface, abdomen and antennae obscure purplish-brown, sterna and undersides of femora dark metallic green.

Head deeply impressed, finely and closely punctate. *Prothorax*: apex and base bisinuate, the former rather strongly produced at middle, anterior angles acute, posterior rectangular, sides moderately rounded at middle, disc with wide oval depression at middle near base and another near each side, a feeble medial carina throughout, surface very finely punctate, except at sides and medial depression, where punctures more obvious. *Scutellum* subcircular, impunctate. *Elytra* lightly enlarged at shoulders, subparallel to beyond half-way, thence tapering to apex, apices rather sharply and separately rounded, not quite covering abdomen, hind margins finely serrated; disc finely seriate-punctate, each with three feeble costae, the first (nearest suture) most obvious; underside closely and finely punctate, abdomen rather thickly clad—especially at sides—with long recumbent hair, the first segment showing greenish metallic gleams, apical segment with two tubercles rather than spines at extremity. *Dimensions*: 10 x 3 (+) mm.

Habitat.—South Australia (?): Monarto (?) (Tepper).

A single male specimen with an indistinct locality label is in the South Australian Museum. It is clearly distinct from other described species, not only by its absence of metallic lustre on the upper surface, but also by its combination of finely punctured surface with sharply attenuated apex, and scarcely spinose abdomen. Type in South Australian Museum.

CURIS YALGOENSIS, n.sp.

Elongate, oblong; head and pronotum olive-green or bluish, the latter with some golden gleams here and there, elytra dark blue, the base, suture and shortly at sides golden-green—becoming coppery at its junction with the darker ground-colour—the metallic colour on suture widening behind middle and terminating before the apex; the exposed pygidium, underside, legs and antennae blue, the underside brilliantly nitid.

Head widely and deeply excavated. *Prothorax*: apex nearly straight in middle, acutely produced at angles, base rather strongly bisinuate, posterior angles also acute and produced, sides well rounded, greatest width rather behind middle, rather suddenly sinuate near posterior angles; disc subalveolate-punctate, the punctures smaller and shallower near middle, larger, deeper and denser towards sides, a smooth medial line faintly indicated, a feeble shallow depression at middle near base. *Scutellum* green, circular, depressed in middle. *Elytra* rather strongly widened at shoulders, a little compressed at middle, again widening before the apical convergence, each apex separately and widely rounded (subtruncate), the margins of apical third strongly serrated, a considerable area of pygidium exposed, this strongly punctate, each elytron with three distinct costae, outlined by rows of rather small, round punctures, the intervals between these rows irregularly punctate, the punctures on metallic sutural area small, those near sides coarse, with rugose margins. Sternal area closely and strongly, abdomen very finely, punctate, margins of segments—especially near sides—with

pale, recumbent hair; apical segment bispinose at extremity; posterior tibiae widely expanded and flattened. *Dimensions*: 15-16 x 5-5½ mm.

Habitat.—Western Australia: Yalgoo (H. W. Brown).

A fine species, the elytra superficially resembling those of the eastern species *C. aurifera* C. & G. in colour and somewhat in sculpture, the punctures being a little finer and the apices less pointed, while in *aurifera* the golden suture is of uniform width and extended to apex. The pronotum is, however, very different in its absence of coloured vittae, bright margins and lateral foveae, with closer and stronger punctures. The prosternum is less closely punctate than in *aurifera* and the expanded hind tibiae are unlike those of any other species known to me. Type in Coll. Carter.

Curis splendens Macl.—In his "Synopsis" (1877) Fairmaire described another species under the above name that is readily recognizable and distinct from Macleay's species. Dr. Obenberger has recently published (Sbornik Entom., 1923, p. 22) a special genus *Neocuropsis* for the reception of what he supposed to be *C. splendens* Macl., but his description and tabulation clearly indicate a reference to *C. splendens* Fairm. (*nec* Macl.). I propose the name *fairmairei* for Fairmaire's species.

Of the special characters by which Obenberger distinguishes *Neocuropsis* from *Curis*, the non-serrate hind margins of elytra seem the most important, though of doubtful generic value. (Both entire and serrate margins occur in the neighbouring genus *Castiarina*). The elytra shorter than the abdomen is more or less true of the females of all the species, while the longer first joint of the post tarsi is of specific force only. I think, therefore, that the genus *Neocuropsis* is superfluous. Both of the above species have short elytra with their apices obliquely truncate; both have a fairly wide distribution in Queensland. The following comparison will help the student to distinguish them. Both are represented in the Macleay Museum and were known to the late Mr. G. Masters.

Curis fairmairei (nov. nom.) = *splendens* Fairm. (*nec* Macl.)	*C. splendens* Macl.
Hind margins of elytra. non-serrate.	serrate.
Pronotum. medial impression deep, sides concolorous with disc or greenish, punctures strongly defined.	medial impression moderate, sides widely coppery, punctures fine.
Elytra. sides concolorous with disc (rarely with apical margin metallic).	sides coppery or golden green.
punctures very coarse, costae well raised.	punctures fine, costae moderately raised.
Underside. "violaceo-cyaneo."	"golden green."

NEOCURIS AURO-IMPRESSA, n.sp.

Above peacock-blue, the sides of pronotum green, the elytra with impressions containing golden flocculence, underside nitid greenish-blue.

Head strongly, not densely punctate. *Prothorax*: apex and base bisinuate, the latter more strongly than the former, anterior angles well produced forward and acute; sides widely rounded, widest behind middle thence converging each way, posterior angles obtuse; disc finely punctate with large medio-basal fovea. *Scutellum* small, transverse. *Elytra* wider than prothorax at base, separately rounded at apex and shorter than abdomen, a considerable area of each occupied

by four gilded impressions, the first triangular at base, between the humeral swelling and the scutellum, the second round, premedial, near suture, the third elongate ovate, postmedial, also near suture, the fourth elongate near sides, exterior to the third, the surface minutely punctate, the punctures becoming coarser at sides; underside strongly punctate. *Dimensions*: 5 x 2 mm.

Habitat.—Queensland, Wide Bay.

A unique example in the Australian Museum, Sydney, bears a locality label in the handwriting of the late G. Masters. The apex of one elytron is mutilated through bad pinning. A species of unusual distinctness. Type, K 32268 in the Australian Museum.

NEOCURIS LIVIDA, n.sp.

Widely oblong, oval; above subnitid blue-black, mouth blue; beneath brilliant peacock blue-green, appendages blue.

Head with a feeble frontal impression and a short sulcus on vertex; evenly, closely and finely punctate, eyes widely separated and parallel as to their inner margins. *Prothorax* rather convex, apex lightly arcuate, base bisinuate, widest at base, thence arcuately converging to apex, anterior angles obtuse, posterior subrectangular (about 80°); rather unevenly and distinctly punctate, the punctures larger and more distant near middle and base, elsewhere smaller and closer; without medial line or foveae. *Scutellum* circular, depressed in middle. *Elytra* oblong-oval, scarcely compressed at middle, apices separately rounded, leaving a considerable portion of the dorsal body exposed; closely scalose-punctate, wrinkled near middle and sides, a foveate depression near shoulders. Underside mirror-like, very finely punctate and entirely glabrous. *Dimensions*: 7.5 x 4 mm.

Habitat.—Western Australia: Perth (Mr. Duboulay), in Melbourne Museum.

A single female example is nearest *N. monochroma* Fairm., which, however, is more brightly coloured and has the elytra "obsoletissime costulatis" and the sides of prothorax "postico leviter sinuato." Type in the National Museum, Melbourne.

NEOCURIS SAPPHIRA, n.sp.

Shortly ovate; the whole surface a concolorous rich blue (in certain lights with a violet gleam), legs violaceous.

Head rather strongly concave, deeply and closely punctate, eyes with interior margins parallel, slightly more prominent in the ♂ than in the ♀. *Prothorax* very transverse, apex nearly straight, base bisinuate, sides evenly, arcuately narrowed from base to apex, all angles a little produced and acute; disc without medial line or foveae, rather evenly covered with moderately large and shallow punctures. *Scutellum* very small. *Elytra* of same width as prothorax at base, scarcely compressed at middle, apices separately rounded, nearly covering abdomen; pro- and metasternum strongly and densely, abdomen finely punctate and glabrous. *Dimensions*: 4½-5½ x 2-2½ mm.

Habitat.—Western Australia: Geraldton (A. M. Lea), in Melbourne Museum.

Two examples are, I consider, sexes of the same species, the male being the smaller, with Mr. Lea's label, the other example is merely labelled W.A. The nearest described species is *viridi-micans* Fairm., which, besides colour difference, is a more elongate species, the head and prothorax narrower. Type in National Museum, Melbourne.

Notes on Stigmodera *described by Dr. Obenberger.*

In Archiv. f. Naturg., 1922, p. 111-123, Dr. Obenberger has described twenty-one new species of *Stigmodera*, together with twelve named varieties or subspecies. As with *Bubastes* the author presumably distinguishes between "subspecies" and "variety," a distinction as difficult to maintain as it is undesirable in this connection. In so protean a genus as *Stigmodera* the naming of varieties could be carried out *ad nauseam*, but should only be done in those rare cases where there is a possibility of specific distinction or a clear local race is indicated.

Of his varieties I note the following:—

S. (*Themognatha*) *suturalis* var. *tincticollis* Obenb. = ? *S. lessoni* C. & G.

S. (*Castiarina*) *leai* var. *fasciosa* Obenb. = *S. dimidiata* Cart. (*vide* These Proc., 1919, pp. 138, 139).

S. sexguttata var. *humeriguttata* Obenb. = *S. puella* Saund.

S. wilsoni subsp. *septentrionis* Obenb. = ? *S. flavopurpurea* Cart.

S. brutella subsp. *victrix* Obenb. = ? *S. uniformis* Kerr.

Most of the other varieties are well known pattern divergences from the normal—e.g. The wide variations of *S. caroli* Blkb. (= *capucina* Blkb.) were recorded in the original description. Of the 21 new species I regard ten as certain and five others as probable synonyms as follows:—

1. *S.* (*Themognatha*) *queenslandica* Obenb. = *S. parryi* Hope.
2. *S.* (*Themognatha*) *desperata* Obenb. = *S. excisicollis* Macl.
3. *S.* (*Themognatha*) *nickerli* Obenb. = *S.* (*Castiarina*) *maculiventris* Macl.
4. *S.* (*Themognatha*) *strandi* Obenb. = *S.* (*Castiarina*) *maculiventris* Macl.
5. *S.* (*Castiarina*) *bizonata* Obenb. = *S.* (*Castiarina*) *secularis* Thoms.
6. *S.* (*Castiarina*) *saundersiana* Obenb. = *S.* (*Castiarina*) *campestris* Blkb.
7. *S.* (*Castiarina*) *circumflexa* Obenb. = *S.* (*Castiarina*) *flavosignata* Macl.
8. *S.* (*Castiarina*) *opacula* Obenb. = *S.* (*Castiarina*) *carinata* Macl.
9. *S.* (*Castiarina*) *modesta* Obenb. = *S.* (*Castiarina*) *venusta* Cart.
10. *S.* (*Castiarina*) *carteri* Obenb. = *S.* (*Castiarina*) *sexguttata* Macl. var.
11. *S.* (*Castiarina*) *bifasciatella* Obenb. = ? *S.* (*Castiarina*) *marginicollis* Saund.
12. *S.* (*Castiarina*) *obliquefasciata* Obenb. = ? *S.* (*Castiarina*) *cupreo-flava* Saund.
13. *S.* (*Castiarina*) *crucioides* Obenb. = ? *S.* (*Castiarina*) *cyanicollis* Boisd.
14. *S.* (*Castiarina*) *dicax* Obenb. = ? *S.* (*Castiarina*) *mastersi* Macl.
15. *S.* (*Castiarina*) *guttifera* Obenb. = ? *S.* (*Castiarina*) *delicatula* Kerr. var. or *tropica* Cart.

Re (1) my note (p. 88 of my Revision) states my reason for considering *parvicollis* Saund. as a synonym of *parryi* Hope, so that the author's words "in der mitte zwischen *parvicollis* und *parryi*" explains the above. (2). Nothing in the description shows distinction from Macleay's species. (3) and (4). Both named *amicta* by Kerremans (in litt.). In my Revision (p. 81) I stated that the very variably patterned *maculiventris* Macl.—the largest of the *Castiarina* subgenus—had been wrongly placed under *Themognatha* by Kerremans, a mistake apparently repeated here. (5-10). I have little doubt of these cases. (5). The habitat given is *Nordaustralien* (sic) *Perth*.

There is a specimen of *S. carinata* Macl. in my collection, labelled *opacula* Kerr., purchased with others in 1912 from a German dealer. Dr. Obenberger appears to have accepted a number of Kerremans' manuscript names without due investigation. No figures are supplied, and in twelve cases no comparison is made between the described species and any of its allies, while important charac-

ters like the presence or absence of serrated hind margins to the elytra are omitted.

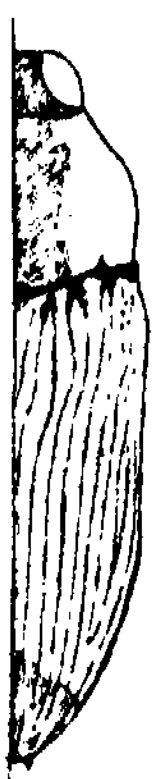
By way of "amende honorable" I must confess that the two species of *Briseis* described (Ent. Soc. Lond., 1923, pp. 101-102) by me are probably synonyms as follows:—

Briseis smaragdifrons Obenb. = ? *B. cuprea* Cart.
B. prolongata Obenb. = ? *B. elongata* Cart.

The German publication, Archiv. fur. Naturgeschichte, was published in December, 1922. My paper, "Melobasis with Notes on Allied Genera," was read 15th November, 1922, but not published till August, 1923.

STIGMODERA (CASTIARINA) THERYI, n.sp. (Text-fig. 4.)

Oblong-ovate, attenuated behind; the greater part of surface above and below red; head, scutellum, medial area of pronotum, a narrow basal band and apex of elytra, and (sometimes) middle of prosternum black; antennae and tibiae greenish, femora blue-black.



*Text-fig. 4.

Head excavate and channelled between the eyes. *Prothorax*: apex and base bisinuate, the former rather prominently advanced in the middle and at the acute anterior angles, the latter with a wide medial lobe; sides well rounded, widest at middle, thence strongly converging to the front, with a feeble anterior sinuation, arcuately converging behind, the posterior angles also produced and acute, closely adapted to the elytra; disc rather coarsely punctate, the punctures more sparse at middle, dense towards sides, a smooth medial line on basal half terminated in a rather undefined fovea; the medial black area vaguely merging into the wider red parts. *Scutellum* prominent, semicircular, depressed in middle. *Elytra* lightly widened at shoulders, feebly compressed at middle, margins entire throughout, apices with a wide oval lunation between two robust exterior teeth, the apical black area small and indefinitely merging into the red; striate-punctate, the seriate punctures only seen as crenulations on the sides of the intervals, these everywhere convex and punctate, in parts transversely wrinkled. Underside finely and closely punctate and glabrous. *Dimensions*: ♂ 16 x 6 mm. ♀ 17-20 x 6.5-8 mm.

Habitat.—New South Wales: Enfield (Ramsay), Ropes Creek and Clarence River (Masters), Blue Mts. (Melbourne Museum).

Its nearest ally, *S. analis* Saund., is clearly separated by the following characters:—(1) more oblong, less attenuate, form, (2) elytral apices rounded, apical margins serrated, (3) prothorax more laterally widened, (4) all dark areas metallic, underside (except 3 apical segments partly red) brilliant dark blue.

In *S. théryi* the medial parts of the sternum are sometimes black, while the dark area of pronotum is vaguely defined, red gleams showing on the dark area. I find the species erroneously labelled *analis* Saund., in the Macleay Museum, and *jucunda* Saund., in the Australian Museum. Eight examples are before me. My example of *S. analis* Saund. is from N. Queensland, taken by Mr. Hacker. Types in Australian Museum.

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*4. *Stigmodera théryi.*

PARACEPHALA VITTICEPS, n.sp.

Widely subcylindric, attenuated in front; coppery bronze, underside and lateral depressions on head and pronotum thickly silvery pubescent, elsewhere sparsely so.

Head as wide at eyes as apex of prothorax; finely punctate, medial channel deeply impressed, a wide lateral impression extending from interior of eye to the base of head, filled with pubescence. *Prothorax*: apex nearly straight (slightly produced at angles), base strongly bisinuate, posterior angles subrectangular, sides lightly rounded, widest behind middle, disc minutely shagreened (finely pustulose as seen under strong lens) with wide and irregular medial sulcus (a narrower sulcus on apical half received into a wider sulcus behind), slightly depressed and pubescent at sides. *Scutellum* triangular. *Elytra* minutely pustulose or shagreened, a feeble costa on each, extending from humeral callus to apex; underside more brightly coppery than above, densely punctate and flocculent pubescent. *Dimensions*: ♂. 8 x 3 (vix) mm. ♀. 10 x 3.6 mm.

Habitat.—Western Australia: Perth (H. M. Giles).

A pair sent me long ago by Mr. Henry Giles, may be readily distinguished from the other large species *P. thoracica* (Kerr.) by the pubescent vittate depressions on the head and differently shaped prothorax, Kerremans's species being widest near apex with an embossed ("bossué") surface. Type in Coll. Carter.

(In the ♂ the apical segment of abdomen is shortly rounded, in the ♀ that segment is more extended with a sinuate outline).

AGRILUS MACLEAYI, n.sp.

Head and legs green, pronotum coppery purple, elytra violaceous, underside golden, antennae blue; sub-glabrous and nitid.

Head impressed between eyes, punctate, with longitudinal strioles on vertex. *Prothorax* widest in front, thence converging and nearly straight to base, the anterior angles lightly, the posterior strongly produced and acute; base strongly sinuate, the medial lobe subtruncate; lateral carinae widely divergent behind, the inferior carina nearly straight; disc strongly transversely striolate. *Scutellum* triangular, its base very transverse. *Elytra* deeply impressed at basal lobes, apices separately rounded and sharply serrated; surface shagreened, at the base and sides transversely strigose, apical half with short sparse light-coloured hairs. Underside finely punctate and glabrous. *Dimensions*: 4 x 1 mm.

Habitat.—Queensland: Cairns.

A minute species not very near any described species—unique in the Macleay Museum.

Agrilus.—Dr. Obenberger has lately described seven species and two subspecies of Australian Agrili (Sbornik Entom. Nat. Mus. Prague, 1923). Of these I cannot but consider four (*raphelisi, van diemeni, domini* and *danesi*) as well as the so-called subspecies (*cooki* and *tasmanicus*) as merely variations of the common and widely distributed *A. australasiae* C. & G., the complicated synonymy of which I recorded recently. The presence or absence (partial or entire through abrasion) of the sutural and lateral pubescence, together with other colour differences noted by Obenberger are not, I consider, specific distinctions, while the variations in the thoracic carinae and gular tooth are of doubtful value. This doubt as to the validity of the distinctions noted in his tabulation is intensified by the inclusion therein of *A. hypoleucus* Sd. (?), *A.*

australasiae C. & G. and *A. flavo-taeniatus* Thoms., as distinct species, with distinguishing characters not to be found in the original descriptions of these species. If Dr. Obenberger has examined the types of these species his information would be valued, otherwise his determinations are open to question. Of the remaining three species described, *A. kurandae* must be very near *A. nitidus* Kerr.; though no comparison is mentioned, *A. korenskyi* may be the species I described as *semiviridis*, but the description of *korenskyi* is lacking in many details. *A. walesicus* is probably the species I mentioned as being near *A. nigritus* Kerr. from Banguey.

APHANISTICUS BLACKBURNI, n.sp.

Wholly black, elongate, subcylindric.

Head deeply cleft and bilobed, with a double system of punctures, the larger round and sparse, the whole surface shagreenate-punctate. Antennae subclavate, the last 4 segments dentate. *Prothorax*: apex slightly produced in middle, more so at the sharply acute angles, base strongly bisinuate, posterior angles rectangular, sides nearly straight (feebly widened on front half), with rather widely horizontal foliate margins, widened at base to meet the flattened basal sides of disc; surface of disc uneven, a wide medial transverse ridge separating a wide apical and a narrower prebasal depression, the whole surface (as on head) with a dense minute system of punctures overlaid with large shallow ocellate punctures sparsely and unevenly placed. *Scutellum* large, triangular, depressed. *Elytra* of same width as prothorax at base, parallel on basal half, thence rather strongly widened before the apex, the latter rather widely and separately rounded, posterior sides entire; seriate-punctate, the seriate punctures coarse and round, the intervals covered with minute punctures as on head and pronotum. Underside minutely punctate, the femora—especially the front—widely laminate. *Dimensions*: 3 x 1 (vix) mm.

Habitat.—Australia (Blackburn Coll. in South Australian Museum).

A single specimen, sent with other Buprestidae for determination, clearly differs from *A. browni* Cart. and *A. endeloides* Cart.—the only other Australian species with bilobed head. Both of these have the prothorax much more widely rounded, with very differently sculptured elytra. Type in South Australian Museum.

TENEBRIONIDAE.

ENDOTHINA, n. gen. *Opatrinorum.*

Body oval, convex, thickly clothed with scales (as in *Ulodes verrucosus* Erich.).

Head trapeziform, short and wide, widest at eyes, deeply sunk in prothorax, eyes large, transverse, prominent, coarsely faceted, antennal orbits not prominent, antennae little longer than head, 1st joint stout, cylindric, longer than succeeding, 2nd cup-shaped, 3rd longer than 4th, 3rd-7th closely adjusted, wider than long, 8th-10th strongly transverse forming a distinct club, 11th much smaller than 10th and partly received within it; palpi with apical joints subulate, mentum transverse, obscured by scales, epistoma narrow, sub-truncate without visible suture; anterior coxae globose, rather widely separated. *Prothorax* strongly transverse, widely emarginate at the anterior angles, sides and base fringed with stout whitish cilia, disc irregular; sides slightly depressed, subfoliate. *Scutellum* transversely oval. *Elytra* closely adjusted to prothorax and

of same width at base, moderately convex; seriate punctate. *Legs* shortish, protibiae stout, much enlarged at apex, outer edge undulately subdentate, inner margin with a few spines; mid and hind tibiae serrated on outside edge, tarsi (especially claws) short. *Prosternum* rather flat, scarcely produced behind coxae, post-intercoxal process semicircular.

A very distinct genus, suggestive of *Gonocephalum* in general structure, of *Ulodes verrucosus* Er. in the scaly clothing, and of *Phaennis fasciculata* in its mottled coloration.

ENDOTHINA SQUAMOSA, n.sp.

Oblong ovate; above tawny-brown variegated with white, beneath and on legs the white scales predominating; antennae also clothed with small white scales.

Head rather flat, surface uneven and coarsely squamose, a thin, shining, interrupted carina at middle, a deep foveate depression on each side of this between the eyes, some longer scaly cilia on vertex. *Prothorax*: apex slightly produced in middle, strongly so at the widely rounded angles; widest in front of middle, wider at base than at apex, sides well rounded, slightly sinuate before the acute posterior angles, the slight dentation accentuated by a cluster of spiny cilia protruding therefrom; base strongly bisinuate, lateral flanges subfoliate, a separating depression strongly marked at base, more feebly in front; disc uneven, with four depressions, the largest triangular, extending from near middle to apex, the second, also medial, near base, and two discal, one on each side, rather behind middle; the white scales forming a rough cross on disc, besides largely shown on lateral flanges. *Scutellum* dark brown, squamose. *Elytra*: shoulders rounded, sides subparallel, apex rather bluntly rounded, the white scales generally in clusters, the more regular forming two lines of clusters, one line on each side of suture; and subfasciate clusters on apical third; the general tawny colour also relieved by some irregular, scattered dark ciliate scales, with rows of circular punctures, like sunken studs in the scaly clothing, between rows of cilia. Legs and tarsi thickly clothed with white cilia. *Dimensions*: 5-5.5 x 3 mm.

Habitat.—New South Wales: Sydney (Ocean Beach at Collaroy; Dr. E. W. Ferguson).

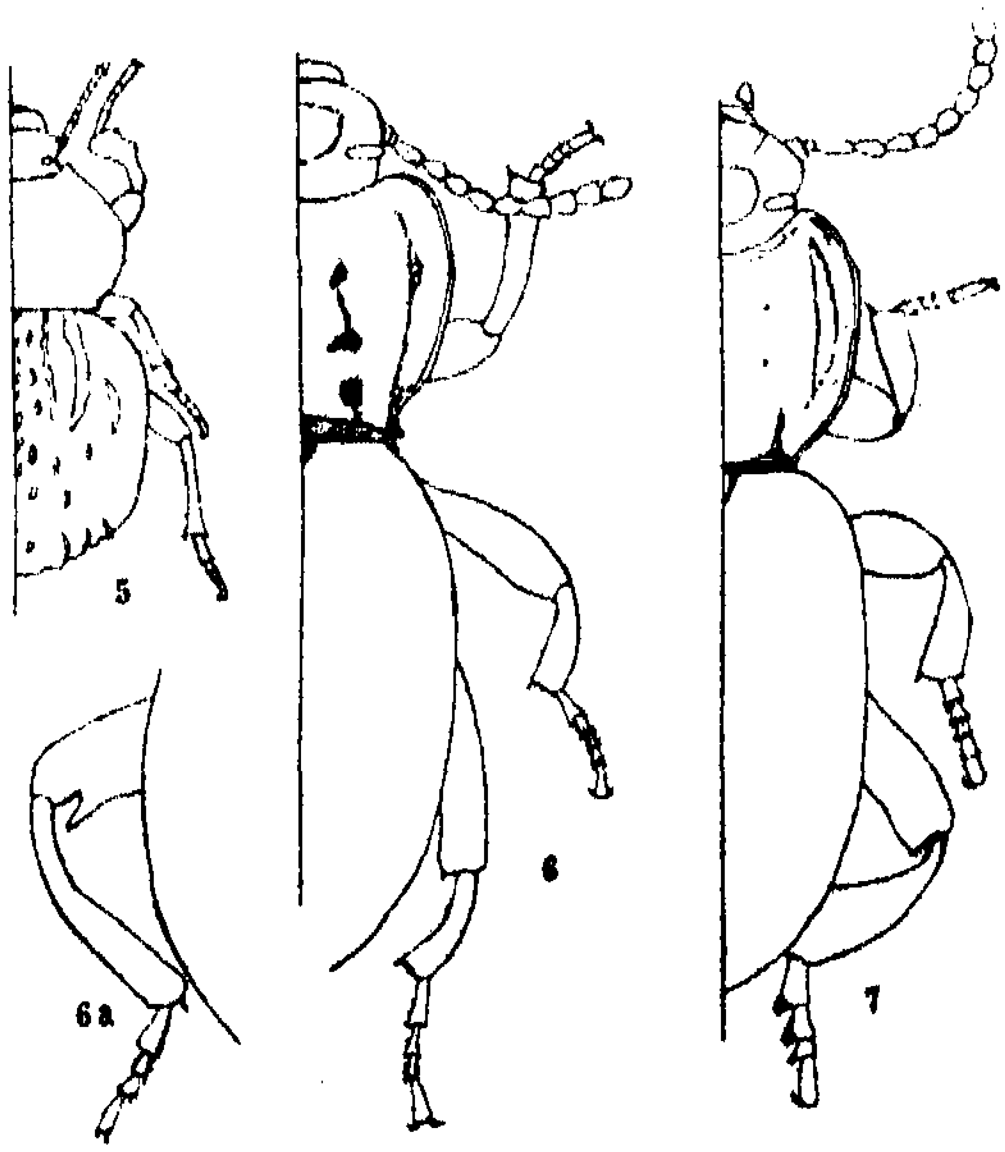
Two examples taken by Dr. Ferguson in February of the present year (1924) form another of our numerous beach-haunting Tenebrionidae, that has escaped notice till now. The rough, scaly clothing is unlike anything in the group to which it appears to belong; but the short, clavate antennae, the structure of head and prothorax, the wide, subdentate protibiae, the ciliate tarsi, widely separate it from *Ulodes verrucosus*. The apical segment of antennae smaller than the preceding is a notable character. Type in Coll. Carter.

DYSARCHUS IRREGULARIS, n.sp. (Text-fig. 5.)

Oval, convex; black, opaque, antennae and tarsi reddish.

Head densely pustulose-punctate, upper surface of eyes small and round, rather deeply sunk; antennal orbits rounded; epistoma triangularly excised in middle, rounded at sides, angulate at junction with antennal orbit; antennae robust, extending to middle of prothorax, 3rd joint equal to 4th and 5th combined, 8th-10th widely transverse, 11th small. *Prothorax* very convex, twice as wide as long, apex and base nearly straight except for the produced angles, the

anterior subacute, directed forwards, sides strongly widened and rounded at middle, converging and sinuate before the rectangular hind angles; foliate margins wide and lightly reflexed, their surface rugose-pustulose, giving a slightly crenulate appearance to the extreme border, surface of disc unevenly and closely rugose-punctate. *Scutellum* very small and deeply sunk. *Elytra* oval, convex, at shoulders rounded and wider than prothorax at its widest; margins strongly crenulate, the disc irregularly sculptured; the more obvious features on each elytron consisting of a few (two to four) short, shining undulate carinae near base; some sparse, irregularly placed pustules (like fragments of the former) on apical half; coarse transverse, pustulose ridges near the sides; the secondary or ground sculpture consisting throughout of dense punctures. Prosternum, parapleurae, epipleurae and abdomen, evenly and distinctly, not closely, punctate — the punctures of abdomen smaller than elsewhere. Legs finely pustulose,



5. *Dysarchus irregularis*. 6. *Cardiothorax foveatus*. 6a. Hind leg of same. 7. *Cardiothorax nasutus*.

front tibiae with two wide teeth at apex; hind tarsi with basal joint nearly as long as the rest combined; a thin coating of red hairs beneath. *Dimensions*: 11 x 6 mm.

Habitat.—Queensland: Stanthorpe (H. Jarvis).

A single specimen, sent by Mr. R. Illidge, is easily distinguished from *D. batesi* Haag.—the only other Eastern Australian species recorded—by the smaller size, irregular sculpture and distinctly punctate surface. It is equally differentiated from the Western species by the absence of the definite lines of pustules on the elytra, amongst other things.

CARDIOTHORAX FOVEATUS, n.sp. (Text-figs. 6, 6a.)

Oblong-ovate, black; head and prothorax (above and below) opaque, elytra and abdomen rather nitid.

Head: epistoma truncate in front, antennary orbits widely rounded, head widest in front of eyes, frontal impression deep, concave within (concavity formed by two large foveae), antennae stout, opaque black. *Prothorax* widest in front of middle, apex arcuate, front angles advanced and bluntly rounded, sides well rounded anteriorly, a little sinuate behind middle, thence rather abruptly and arcuately narrowed to hind angles—these bluntly dentate, and twisted outwards and downwards; base widely angulate in middle, extreme border narrowly raised throughout; foliate margins wide, subhorizontal, separated from disc by sulcus; disc with two deep foveae at middle of each lobe, a clearly impressed medial sulcus, triangularly widened behind to join a rather wide, basal, transverse depression. *Scutellum* arcuate-triangular, convex. *Elytra* slightly wider than and two and a half times as long as the prothorax, shoulders widely rounded; the sculpture very irregular; chiefly consisting of lines of foveae formed by strongly undulate costae, the four alternate costae (1, 3, 5, 7) more strongly raised and less undulate than the rest. Underside smooth, in the male all femora more or less armed, the hind with a large conical tooth near apex, intermediate femora with a longer, carinate tooth, the front femoral tooth just traceable, all tibiae curved and widened, the hind tibiae strongly so; their apices strongly spined. In the female all femora unarmed, tibiae straight and normally wide. *Dimensions*: 21-23 x 7½-8½ mm.

Habitat.—S. Queensland: Stanthorpe (F. A. Perkins).

Six males and eight females sent by Mr. Perkins, of the Queensland Department of Agriculture, of this very distinct species, one of the finest of the genus. The elytral sculpture is unique in the genus, and very irregular, no two examples being quite alike. It is a member of the first group in my table (Trans. Roy. Soc. S. Aust., 1914, p. 395) "Femora armed in ♂," but is very dissimilar from its nearest allies (*armipes* Bates and *opacicollis* Macl.) in sculpture. Types sent to the Queensland Museum.

CARDIOTHORAX NASUTUS, n.sp. (Text-fig. 7.)

Oblong-ovate; nitid black, antennae and tarsi brown.

Head with epistoma bluntly dentate and reflexed in middle, the stirrup-shaped frontal impression having a few punctures on it; antennae stout, 3rd joint little longer than 4th, 8th-10th widely ovate, 11th pyriform. *Prothorax*: apex arcuate-emarginate, base sub-truncate, the lobal margins straight, but not quite collinear, anterior angles rather widely rounded, sides widest in front of middle, subsinuate near the widely obtuse, non-dentate hind angles, the medial part nearly straight; extreme border thick, foliate margins separated from disc by a wide shallow sulcus; each with three setae, at wide intervals; disc with medial sulcus throughout, two small punctures near middle of each lobe and a deep basal impression like an inverted T (the transverse bar at base). *Elytra* sulcate, each with seven convex intervals and two sub-obsolete convexities at sides, the 3rd and 5th clearly wider than the 2nd and 4th. Underside and epipleurae impunctate. Middle and post-tibiae widely dilated, the latter arcuate on the superior edge; post-tarsi strongly fringed with pads of hairs forming a lateral extension on inside. *Dimensions*: 22 x 7 mm.

Habitat.—New South Wales: Port Macquarie.

The unique male example known to me has been generously given me by my friend, Mr. R. Illidge. It is one of the largest species belonging to the *acutangulus-castelnaudi* group in which the males have widely expanded tibiae

and may be distinguished by the combination of large size, nitid black colour, non-dentate hind angles of prothorax and unequal elytral intervals. The reflected clypeal tooth and post-tarsal pads are characteristic, *C. politicollis* Bates containing some approach to the former and *C. laticollis* Cart. to the latter of these characters. Type in Australian Museum. ♀ latet.

LICINOMA ILLIDGEI, n.sp. (Text-fig. 8.)

Elongate oblong, blackish bronze, glabrous; antennae, palpi and tarsi reddish-brown.

Head sparsely, minutely punctate with deep arcuate suture, and two large punctures, close together in a depression near base of forehead; antennae with 3rd segment one and a half times longer than 4th, 4th-11th increasing in size, subtriangular, 11th ovate. *Prothorax*: apex subtruncate, the narrowly rounded anterior angles feebly advanced, base truncate, sides evenly moderately arcuate, extreme border narrow, disc impunctate, medial sulcus lightly impressed, two foveae on each side of this (very faintly visible in one example), hind angles obtuse. *Scutellum* small, triangular. *Elytra* considerably wider than prothorax, humeri wide; sulcate; intervals convex and impunctate, the 3rd, 5th and 7th clearly wider than the rest; one or two setae on the 3rd interval near apex. Underside almost impunctate, the epipleurae with small, sparse punctures; hind tarsi with basal segment longer than claw segment. *Dimensions*: 12 x 4.5 mm.

Habitat.—Queensland National Park (R. Illidge).

Two specimens sent by the captor, to whom it is dedicated, show a large species readily distinguished from all described species except *angusticollis* Cart. by its impunctate elytral sulci. From *angusticollis* Cart. it is differentiated by darker colour, larger size and the unequal elytral intervals. Type in Coll. Carter.

LICINOMA MAJOR, n.sp. (Text-fig. 9.)

Elongate obovate, black, nitid, glabrous; antennae and palpi piceous, tarsi reddish.

Head almost impunctate, suture deep, a single fovea on vertex; antennae submoniliform, 3rd segment one and a half times longer than 4th, 4th-8th oval, 9th-10th subglobular, 11th largest, oval. *Prothorax*: apex lightly emarginate, wider than base, the rounded anterior angles a little advanced, base subtruncate, lightly advanced in middle; sides moderately rounded, widest in middle, posterior angles rather widely rounded, medial sulcus indicated only by a basal notch, a longitudinal depression on each side terminating behind in a fovea; disc impunctate. *Scutellum* larger than usual, semicircular. *Elytra* wider than prothorax at base, shoulders rounded but accentuated by epipleural fold, widest behind middle; sulcate, intervals lightly convex and of subequal width, impunctate, with a few setae near apical third. Epipleurae and mesosternum finely punctate, rest of underside impunctate. Hind tarsi with basal segment as long as the claw segment. *Dimensions*: 14 x 5 mm.

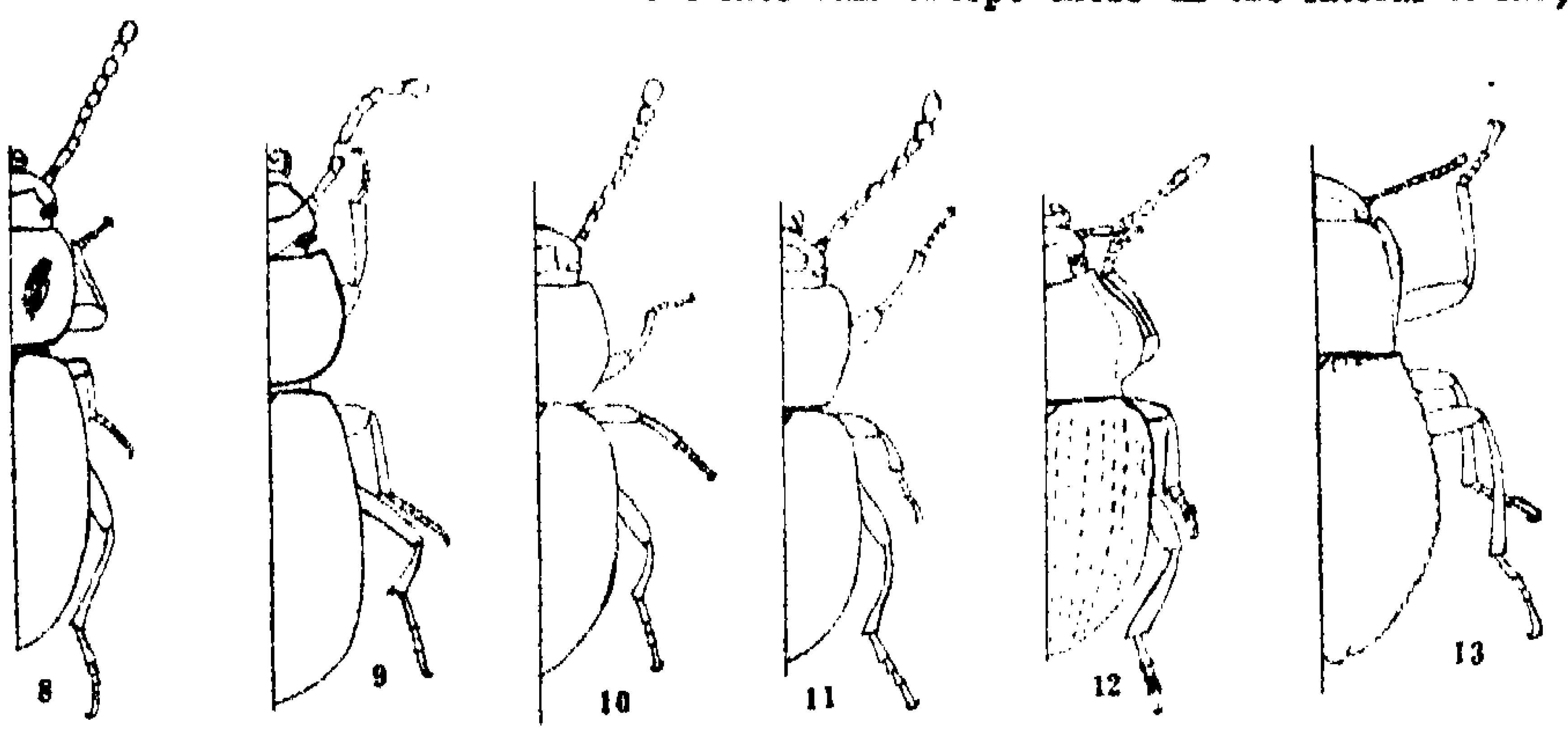
Habitat.—Queensland National Park (R. Illidge).

A single example sent by its captor shows the largest species yet described. It may be distinguished from the other sulcate species by large size, black colour, and the arcuate base of pronotum with its hind angles quite rounded off. Type in Coll. Carter.

LICINOMA SPLENDENS, n.sp. (Text-fig. 10.)

Elongate ovate; head and pronotum brilliant fiery coppery, elytra blue or violet, antennae, palpi and legs red, underside glossy black.

Head unevenly punctate, frontal impression subhexagonal with two large foveae besides punctures; antennae moniliform, 3rd joint one and a half times as long as 4th, 4th-10th oval, successively widened, 11th elongate ovate, much longer than 10th. *Prothorax* sub-scutate, convex, wider than long, greatest width in front of middle, apex nearly straight, the slightly blunted subrect-angular angles feebly advanced, apex clearly wider than base, sides arcuately converging to base, posterior angles obtuse, base truncate, lateral border nar-rowly horizontal with two or three setae, this border widening at front angles; disc without medial line or foveae (in some examples a vague impression near middle at base), the whole with fine shallow, rather close punctures. *Scutellum* black, small, triangular. *Elytra* slightly wider than prothorax at base and twice as long, shoulders obliquely rounded; striate-punctate, the punctures only visible as crenulations on the insides of the intervals except those in the lateral striae;



8. *Licinoma illidgei.* 9. *L. major.* 10. *L. splendens.* 11. *L. coerulea.* 12. *Adelium illidgei.* 13. *Austropeus pustulosus.*

intervals rather widely convex, of equal width, the 3rd with two or three setae, the margins also setose; underside almost entirely impunctate; front tarsi of ♂ slightly enlarged, hind tarsi with 1st joint about as long as the claw joint. *Dimensions*: 9.5-14 x 2.5-4 mm.

Habitat.—S. Queensland: Stanthorpe (F. A. Perkins).

Another fine discovery of this enthusiastic entomologist. Thirteen examples sent for examination show one of the most beautiful insects in the whole sub-family Adeliinae. Its brilliantly contrasted colours will alone distinguish it from other described species. By its structure it should come near *apasioides* (No. 21) of my table (These Proc., 1920, p. 244). Its size is very variable as in other species of which I have seen a long series. Type in Queensland Museum.

LICINOMA COERULEA, n.sp. (Text-fig. 11.)

Elongate oblong-ovate; upper surface rich dark blue, antennae, palpi and legs red, underside nitid black.

Head rather coarsely punctate, epistoma setose, the deep rhomboidal frontal impression bifoveate; antennae narrower than in *splendens*, 8-10 more strongly

widened in proportion to 4-7, the 11th pyriform, wider and longer than 10th. *Prothorax* sub-cordate, flatter than in *splendens*, apex lightly arcuate, anterior angles more prominent and sharper than in *splendens*, greatest width near front, there the rounding of the sides most marked, thence rather straightly narrowed and feebly sinuate before the defined posterior angles; these slightly wider than 90°, margins very narrowly sulcate with one or two setae; base truncate; disc minutely and densely punctate, medial channel finely and clearly impressed throughout. *Scutellum* black, triangular. *Elytra* wider than prothorax at base, shoulders more prominently raised and more squarely rounded than in *splendens;* deeply striate-punctate, the punctures in striae scarcely visible except in lateral striae; intervals equal and sharply convex (sub-carinate), without evident setae; underside almost impunctate; hind tarsi with 1st joint about as long as claw joint. *Dimensions*: 11.5 x 3.5 mm.

Habitat.—S. Queensland: Stanthorpe (F. A. Perkins).

A single specimen examined of a species little less brilliant than the preceding, also separated from its nearest allies by colour and clearly distinct from *splendens* (apart from colour) by its differently shaped prothorax with its pronounced medial sulcus, and the sharply raised elytral intervals. In my table it should be placed near *truncata* (No. 22). Type in the Queensland Museum.

ADELIUM ILLIDGEI, n.sp. (Text-fig. 12.)

Convex, widely ovate; coal-black, moderately nitid, glabrous, antennae, palpi and tarsi red.

Head coarsely rugose-punctate, antennal segment 1 stout, 2 bead-like, 3 cylindric as long as 4-5 combined, 4-10 subconic increasing in size outwards, 11 elongate oval. *Prothorax*: apex semicircularly emarginate, anterior angles acute, pointing forwards, base truncate, sides widely diverging from apex till near base, then abruptly rounded and sinuately contracted, posterior angles acute and pointing outwards, foliate margins wide but not differing from disc in sculpture; this unevenly rugose-punctate with some smooth vermiculate impressions; medial sulcus clearly impressed on apical half, merging into an indefinite depression near base. *Scutellum* curvilinear triangular, minutely punctate. *Elytra* considerably wider than prothorax at base (widest at humeri) and two and one-third times as long, shoulders rather squarely rounded, apex widely rounded; the sculpture formed by interrupted striae, the lightly convex intervals with irregular transverse connections on same level as intervals, the 3rd and 5th intervals clearly wider than the rest; intervals not perceptibly punctate; prosternum and abdomen nearly smooth, epipleurae (especially the prosternal) with large, sparse punctures; intercoxal process widely rounded. *Dimensions*: 12 x 6 mm.

Habitat.—Queensland National Park (R. Illidge).

I name this very distinct species after the Queensland naturalist who has made such valuable observations over a wide range of fauna. The species is, in general form and elytral sculpture, nearest to *A. reticulatum* Cart. and *A. geminatum* Pasc., but is more convex than either, without a touch of bronze, and distinguished from both by the widely excised sides of pronotum in which character it is nearest *A. angulicolle* Casteln., but with a finer border and sharper posterior angles than that species. Type in Coll. Carter.

N.B.—*A. reticulatum* Cart. is readily distinguished from *A. geminatum* Pasc. by its darker colour and clearly punctate elytral intervals.

AUSTROPEUS, nov. gen. *Helopinae.*

Body apterous. Head enclosed in prothorax to the eyes: antennal orbit horizontal, widely rounded, slightly impinging on eyes; these transversely oval, not prominent. Epistoma broadly rounded in front, scarcely separated from forehead, labrum not prominent, apical segments of palpi securiform, mentum trapeziform, wider in front than behind, antennae not reaching base of prothorax, apical segments flattened, 1st stout, 2nd bead-like, 3rd cylindric, longer than 4th, 4th-6th obconic, 7th-10th sub-spherical, 11th oblong-oval, considerably larger than 10th. *Prothorax*: apex strongly emarginate, moderately convex, wider than long; base sub-truncate. *Scutellum* small, triangular. *Elytra* convex, obovate, striate-punctate; *prosternum* convex, its hind process triangularly sharpened and widely margined; coxae globose, hind intercoxal process rounded and margined. Legs rather long, tibiae not enlarged nor spined at apex. Tarsi rather short; *post tarsi with* 1st *segment shorter than* 4th, and as long as 2nd-3rd combined. A genus unlike any other Australian genus, with a facies somewhat resembling *Simarus* of the Cistelidae.

AUSTROPEUS PUSTULOSUS, n.sp. (Text-fig. 13.)

Ovate, convex, glabrous, opaque-brown; antennae and tarsi reddish.

Surface of head and pronotum densely and finely rugose-pustulose; the outline of the epistoma and antennal orbits almost a semicircle, eyes rather small. *Prothorax*: apex sub-truncate in middle, the anterior angles rather sharply prominent, pointing forwards, sides moderately rounded, widest about middle, scarcely sinuate behind, posterior angles sub-rectangular, clearly defined, sides and front narrowly margined, the former narrowly horizontal within the margin—at least on front half. *Elytra* slightly wider than prothorax at base; humeri prominent, subrectangular with extreme angle rounded; apical declivity steep; striate-punctate, the seriate punctures foveate and distant, with about nine convex intervals on each elytron, each with a single row of nitid pustules—the pustules near middle round, becoming more elongate and irregular towards sides (here forming irregular crenulations); the suture and third interval forming strong ridges at apex. Sternal area pustulose, episterna coarsely punctate, abdomen densely and more finely punctate, underside of legs alveolate-punctate; fore and mid tibiae slightly arched, tibiae not enlarged at apex, their apices and tarsi clothed with short golden pubescence. *Dimensions*: 12.5 x 6 mm.

Habitat.—(?) Murchison district of Western Australia.

The locality is given with doubt, the unique example being one of several Coleoptera given by Mr. C. French to Mr. F. Erasmus Wilson, in spirits without label, but probably from the Murchison River region. Mr. Wilson has generously passed it on to me. After considerable hesitation, I place it amongst the Helopinae, near *Mimopeus*. Type in Coll. Carter.

CISTELIDAE.

ATOICHUS FLAVIPES, n.sp.

Oval; head, prothorax, scutellum and legs testaceous; antennae, elytra and underside black.

Head and *prothorax* more strongly punctured than in *A. bicolor* Blackb., the antennal joints wider. *Prothorax* widest at base, lightly, arcuately converging to apex, base and apex truncate. *Elytra* wider than prothorax, sub-parallel

for greater part, very finely sub-striate-punctate, about two striae near suture fine but distinct, the rest ill-defined or obsolete, under a Zeiss binocular the fine seriate punctures are seen to be closely set (both rows and punctures) and scratch-like. *Dimensions*: 4½ x 1¾ mm.

Habitat.—Bribie Island, Moreton Bay (H. Hacker and A. M. Lea).

A single example sent by Mr. Lea is clearly distinct from *A. bicolor* Blackb., not only by colour differences, but by its distinct elytral sculpture, which in *bicolor* is clearly striate-punctate throughout—the striae more distant and the punctures larger than in *flavipes*. Type in South Australian Museum.

A second example varies in having the posterior legs partly dark with knees and basal half of tibiae only yellow.

Atoichus dimidiatus, n.sp.

Oval; head, thorax, scutellum, basal half of elytra, basal joints of antennae, four front legs and posterior knees testaceous; antennae (except basal joints), apical half of elytra, underside and posterior legs (except knees) black, tarsi piceous, upper surface clothed with short, fine hair.

Head and *prothorax* very similar to the preceding, the antennal joints more slender (less oblong), the pronotal punctures finer. *Elytra* clearly striate-punctate, the seriate punctures comparatively large and well separated, the intervals flat and apparently impunctate. *Dimensions*: 4½ x 1½ mm.

Habitat.—Queensland, Bribie Island, Moreton Bay (H. Hacker and A. M. Lea).

A single example from Mr. Lea is distinct in colour and sculpture from the other described species. It is smaller and narrower than *A. bicolor* Blackb. The dark portion is rather less than half the elytra. Type in South Australian Museum.

N.B.—The apical joint of antennae in both the above species, as also in the others (at least in *bicolor* and *tasmanicus* now before me), is smaller (especially finer) than the tenth. All the species show marked differences in their antennae.

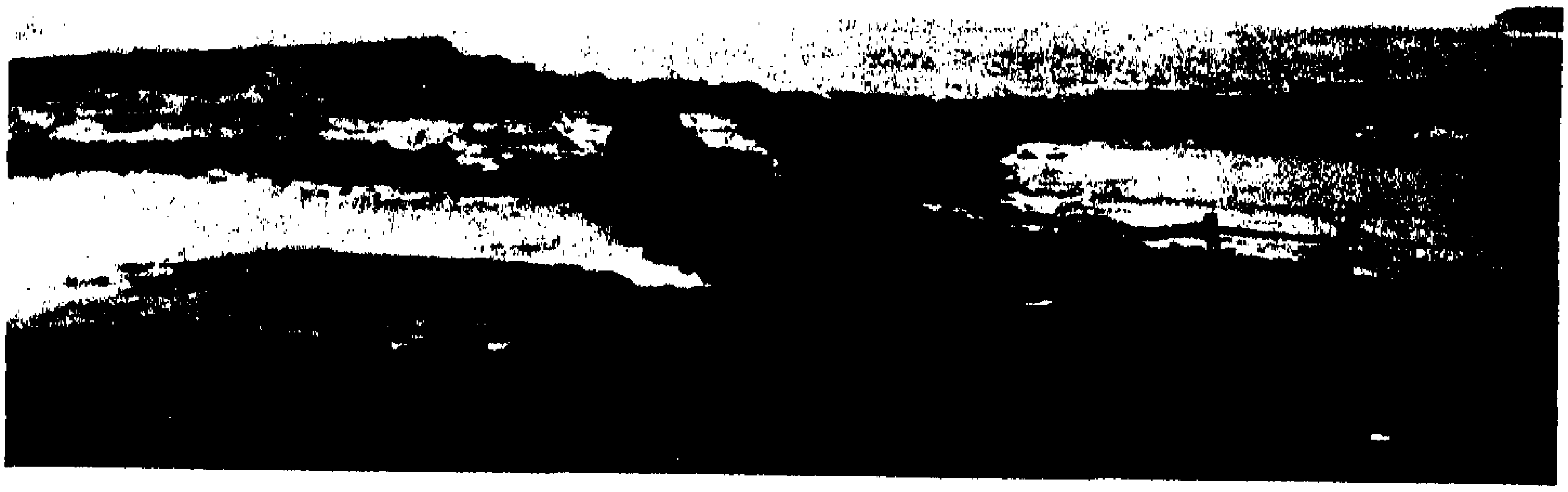
INDEX

(1924).

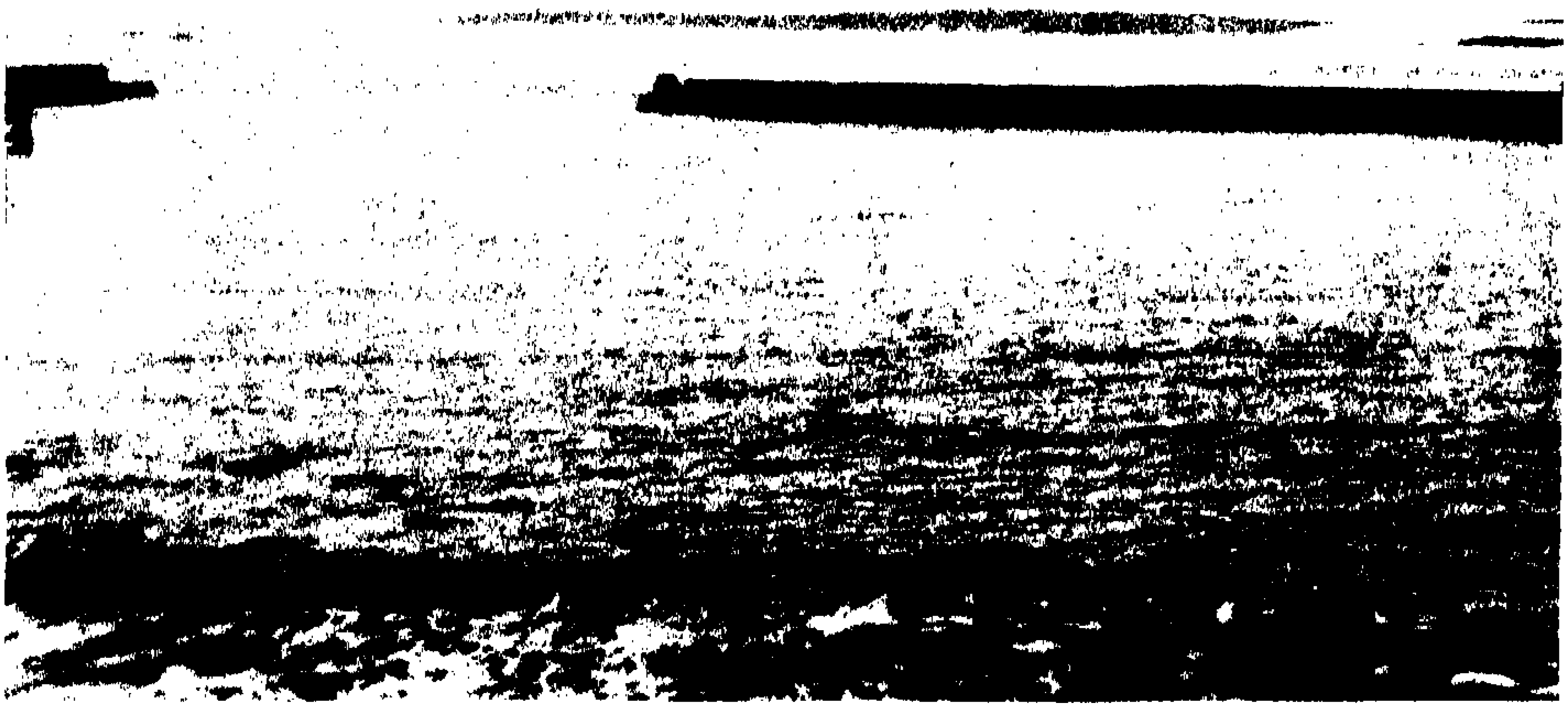
(a) GENERAL INDEX.

BIOLOGICAL INDEX.

Synonyms are printed in *italics;* new names in small CAPITALS.

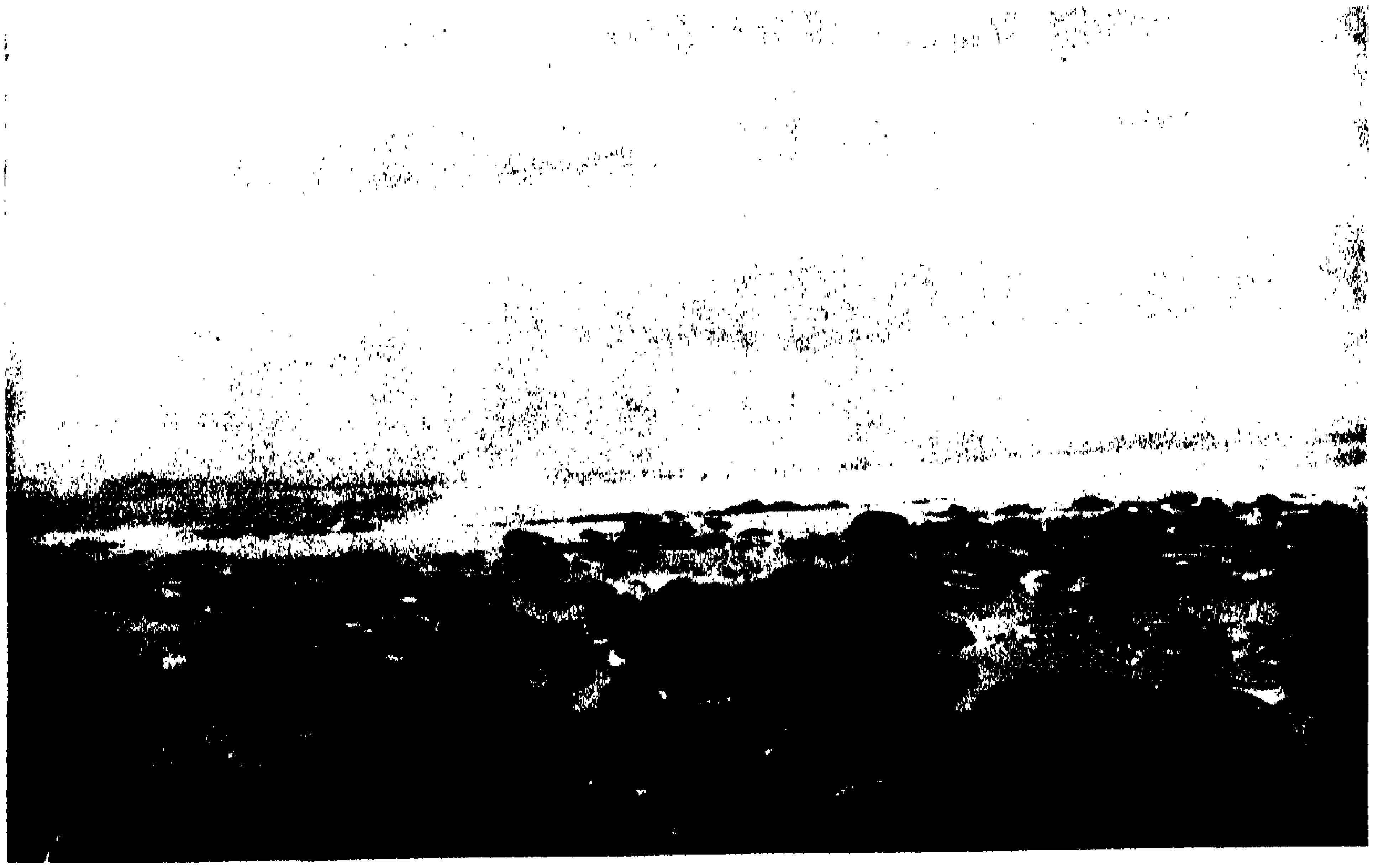


Cowrie Island, Shellharbour, N.S.W. Easter, 1923.



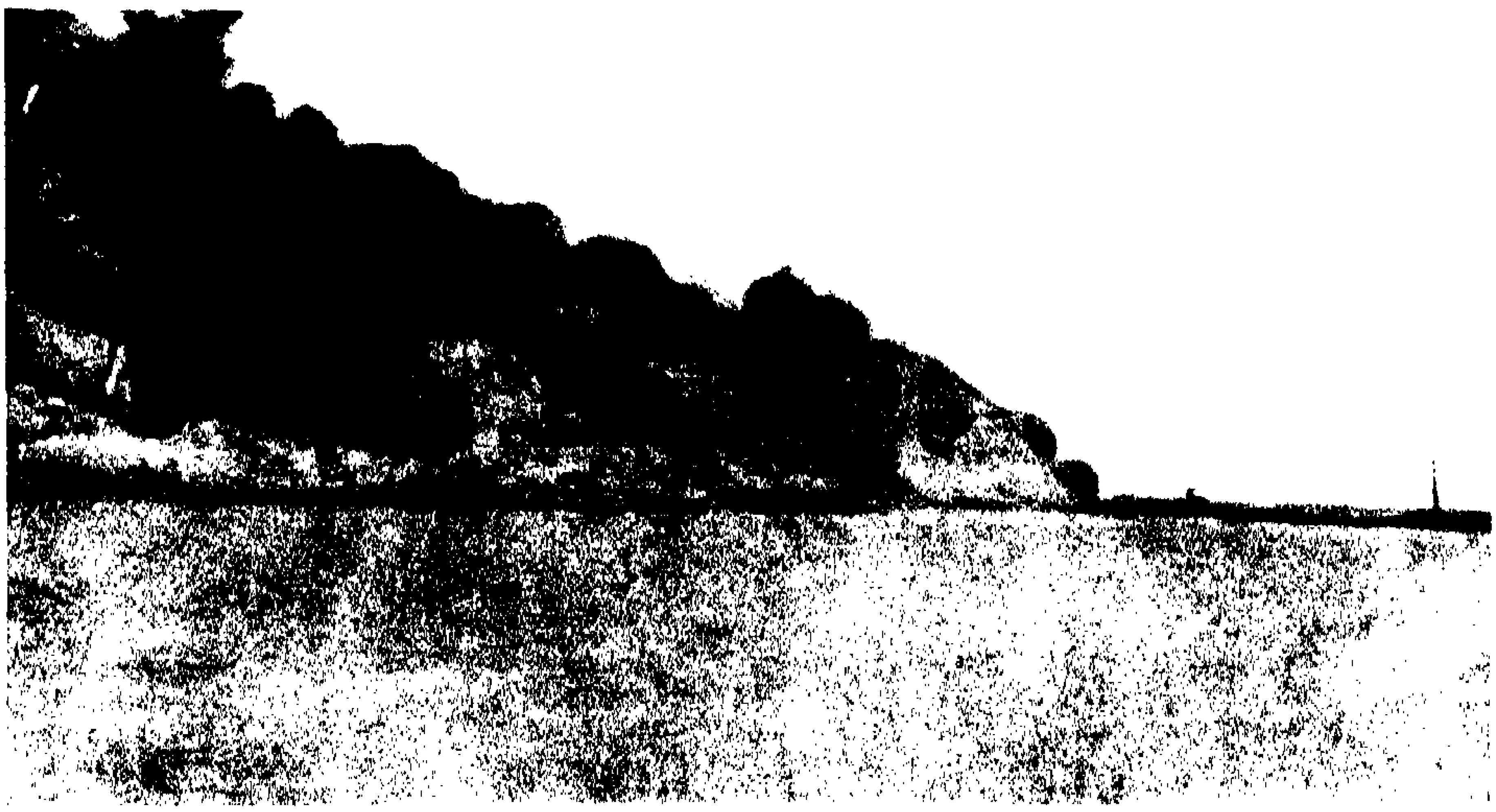
Shellharbour, N.S.W. Easter, 1923.

Moffat Head, Caloundra, Q Northern end of beach.

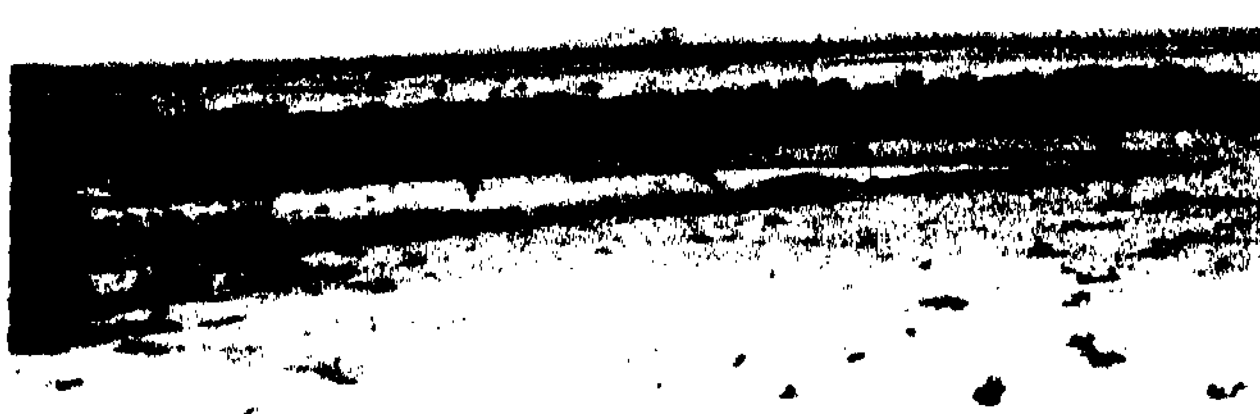


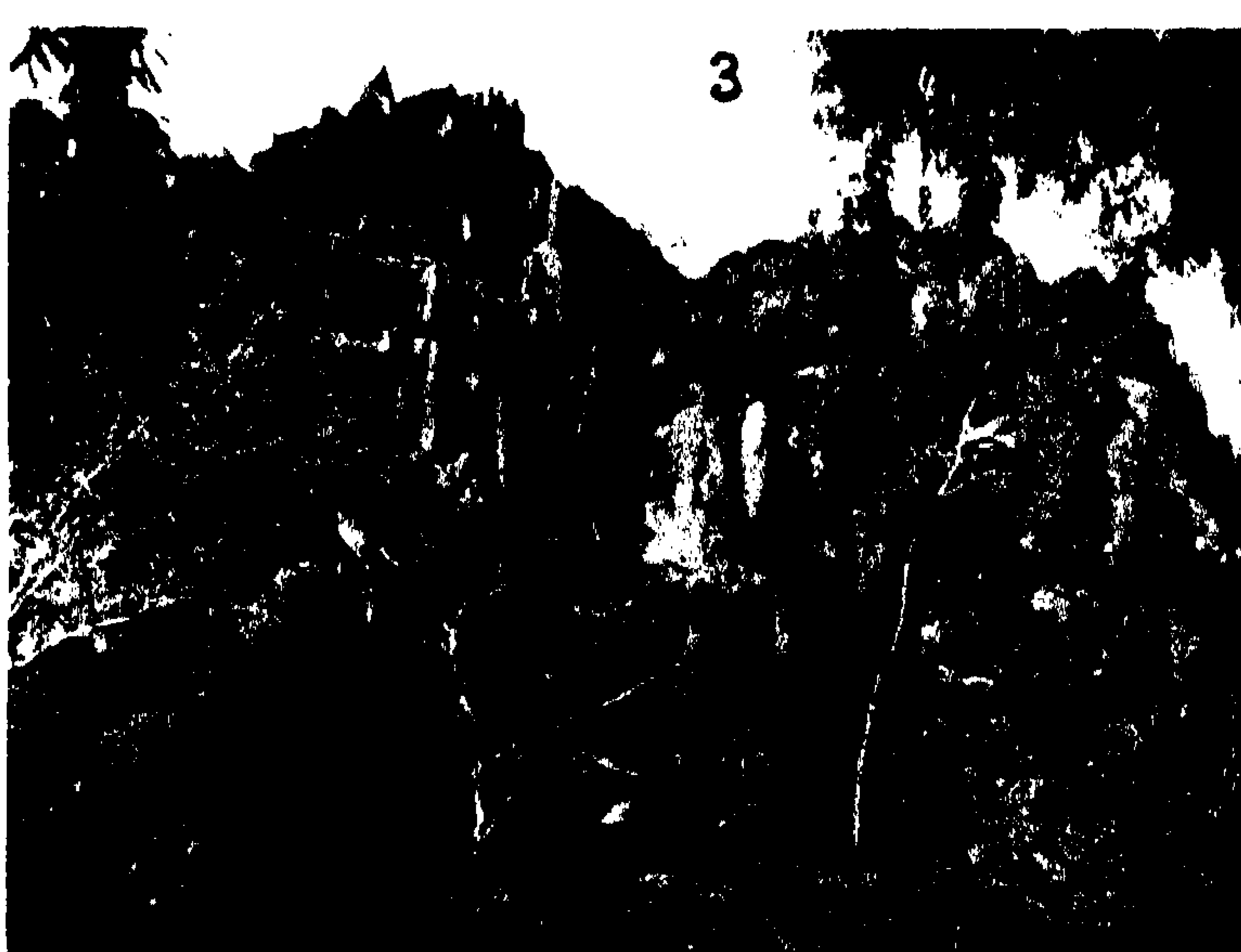
Point Cartwright, Q.

Port Macquarie, N.S.W.



Magnetic Island, near Townsville, Q.





1. Western fringe of Grey Range at Yandama, N.S.W.
2. Low hills of Grey Range from Mt. Poole.
3. Vertical slate outcrop at Sturt's Depot Glen, Mt. Poole.

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4. Gibber and rubble slope colonised by community of *Sarcostemma australe*.
5. Gibber slope with community of *Atriplex vesicarium*, Yandama.
6. Gibber slope near Yandama Creek, with *Acacia Cambagei*.

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7. Open scrub near Mt. Arrowsmith. Groundflora, *Myriocephalus Stuartii; Eremophila Sturtii* at side; *Acacia aneura* in distance.
8. *Grevillea striata* on sandy plain west of Yandama.
9. *Eremophila polyclada* (?) on clayey flat, Grey Range.
10. *Acacia Murrayana* on sand ridge, north-west of Grey Range.

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11. Open sandy plain with community of *Atriplex vesicarium*.
12. Sand ridge west of Grey Range. "Monospecific" community, *Heterodendron oleaefolium*.
13. *Heterodendron oleaefolium*, near Yandama, showing exposure of roots by wind erosion.

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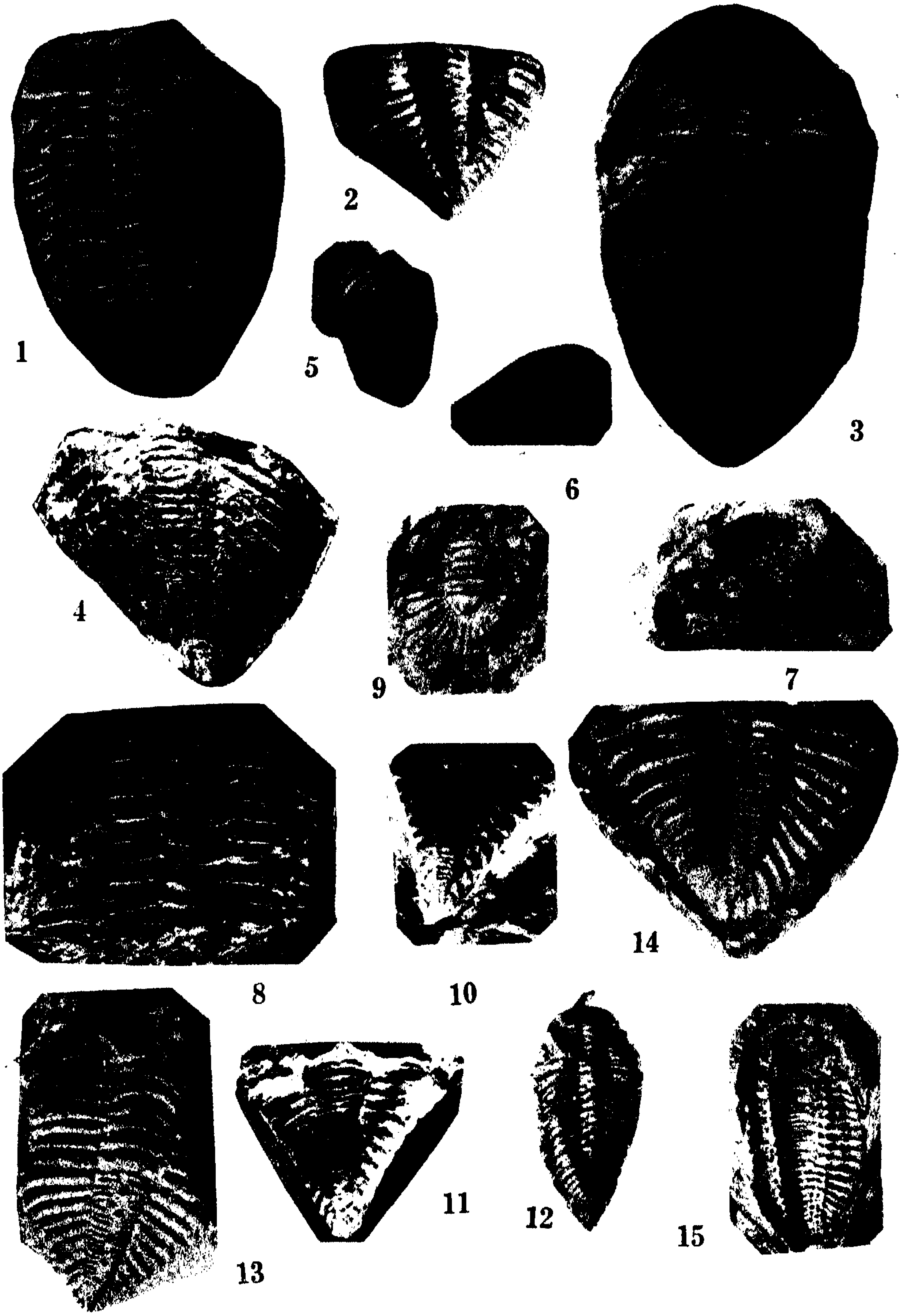
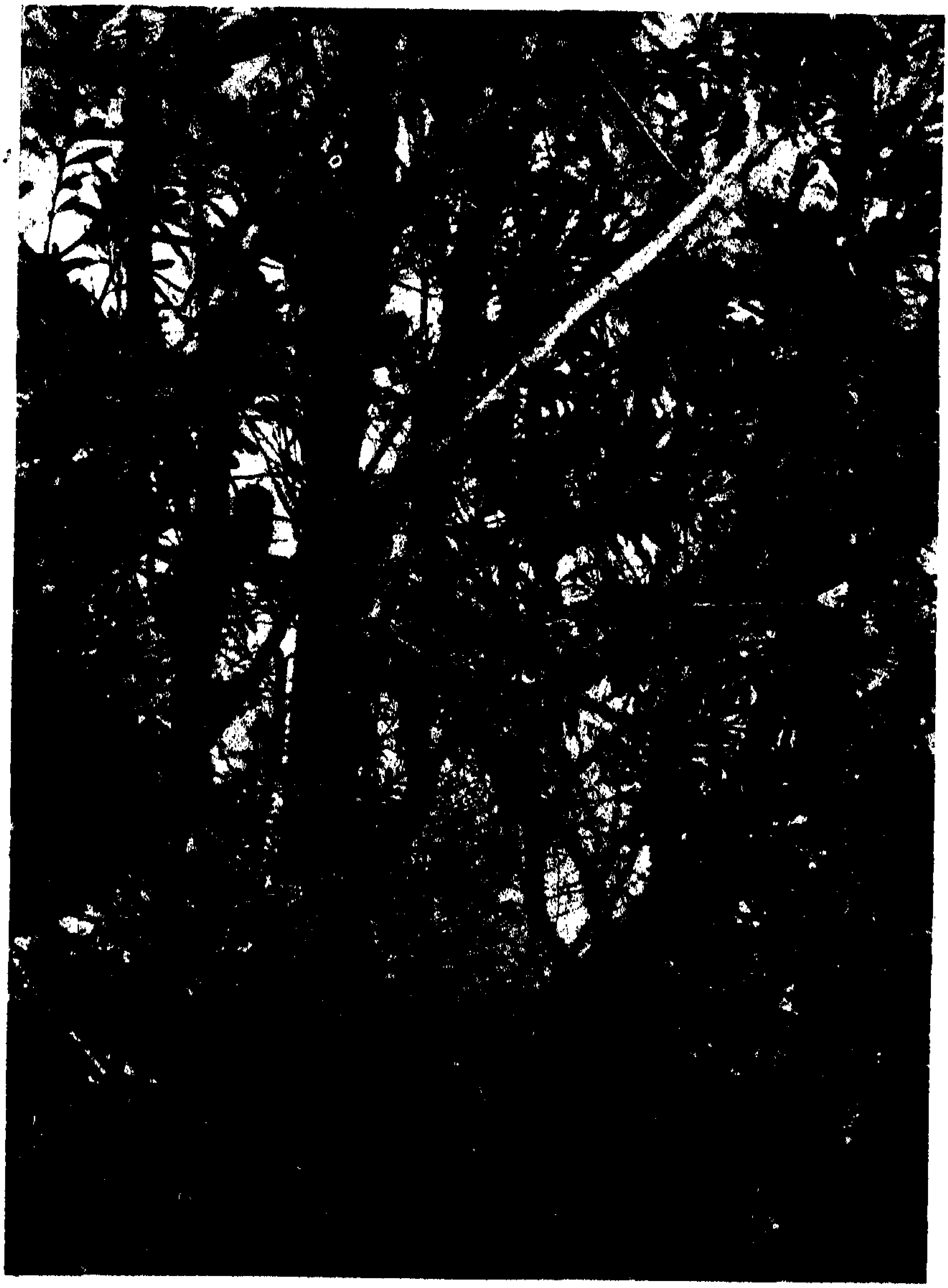
14. Mulga scrub (*Acacia aneura*) on sand ridge west of Grey Range.
15. Part of claypan bordered by open saltbush plain. Colonisation of pan by *Glyceria ramigera* has commenced.
16. Claypan reclaimed by *Glyceria ramigera*.

17. *Acacia Cambagei* in creek bed, Mt. Poole

18. *Eucalyptus rostrata* in Yandama Creek.

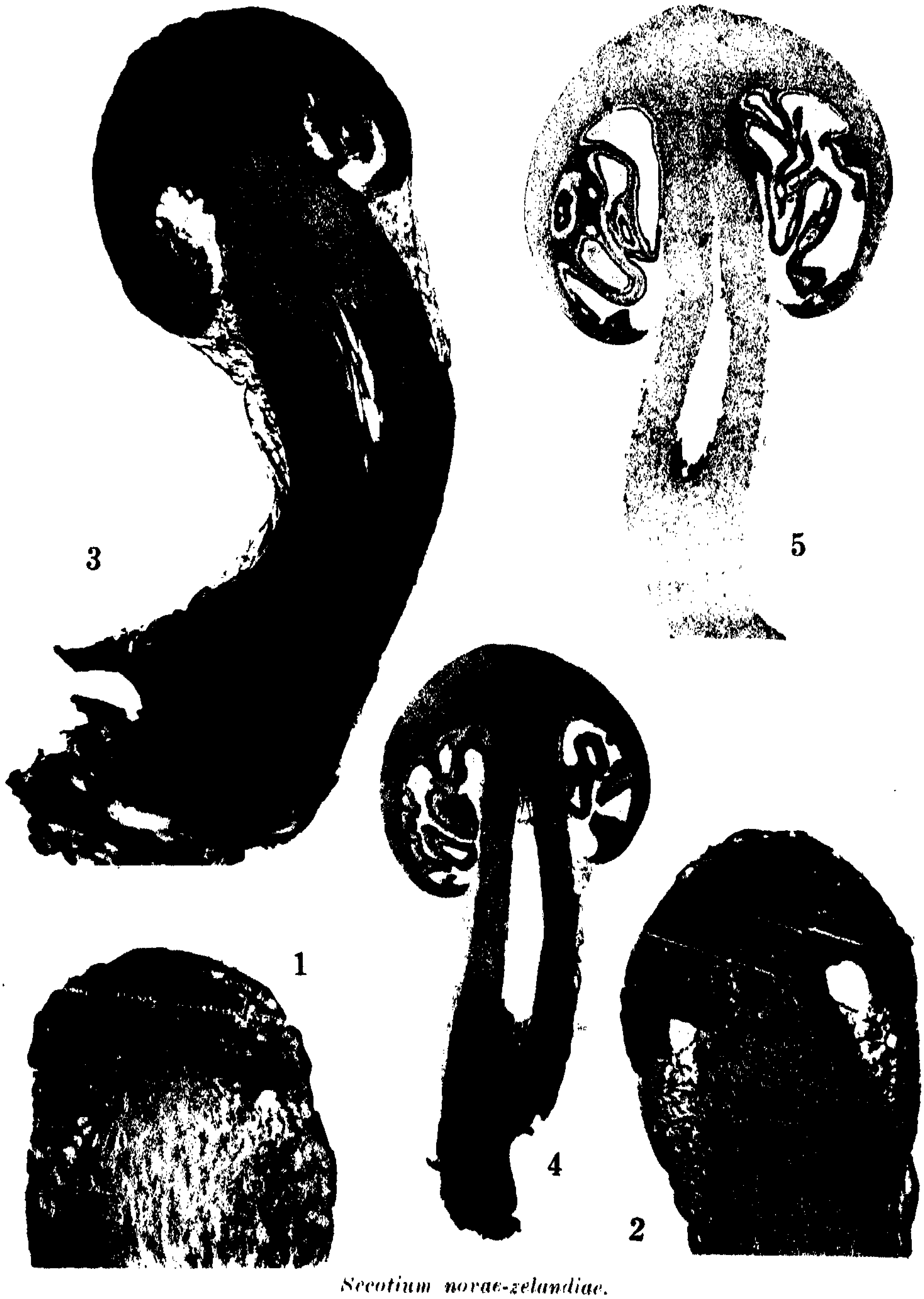


New Trilobites from Bowning, N.S.W.

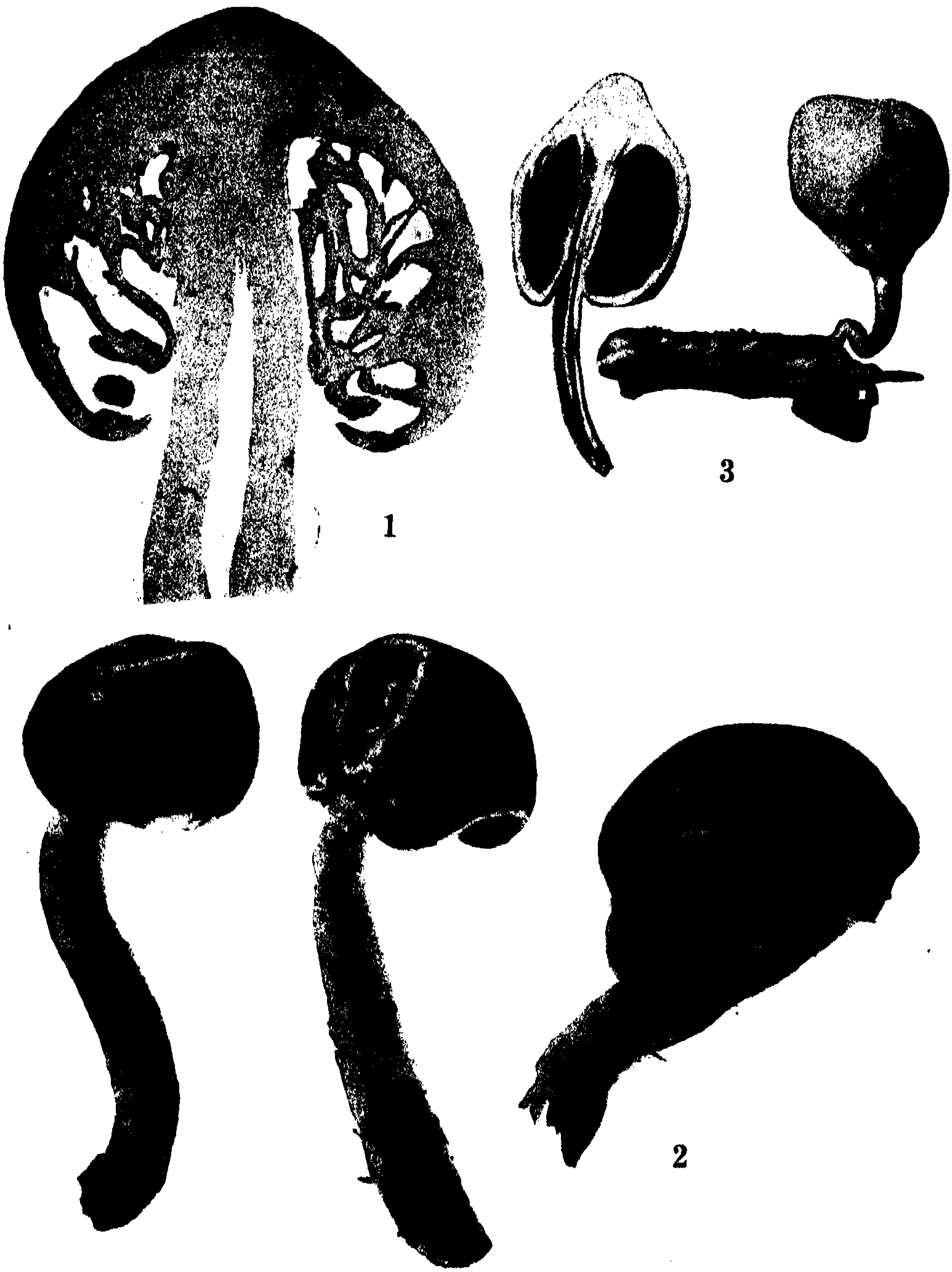


General habit of *Cassytha.*

Photograph of *C. paniculata* growing upon several hosts, especially *Lasiopetalum ferrugineum* and *Banksia latifolia.*



Secotium novae-zelandiae.



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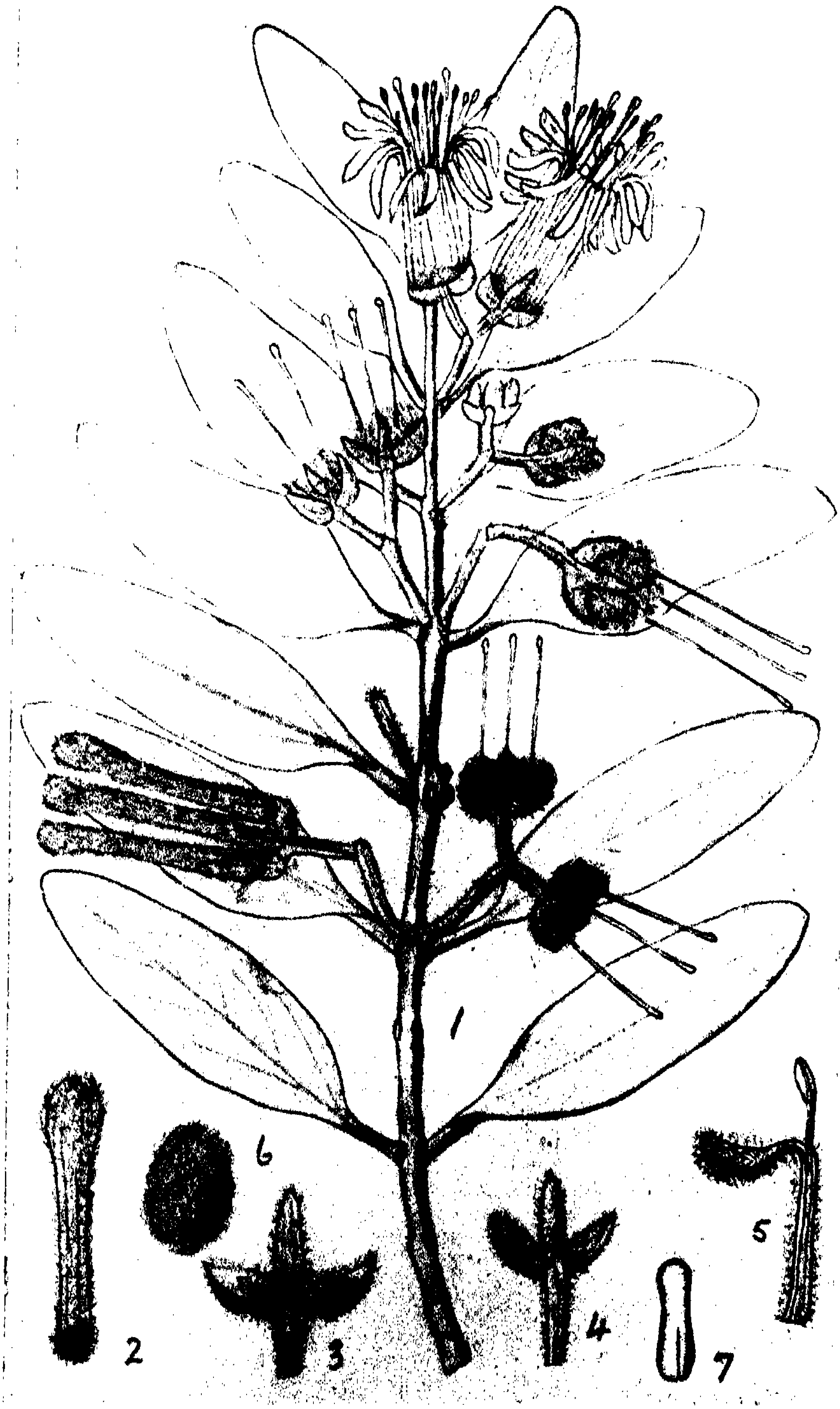
1, 3. *Secotium novae-zelandiae.* 2. *S. erythrocephalum.*

1. *Secotium erythrocephalum.*

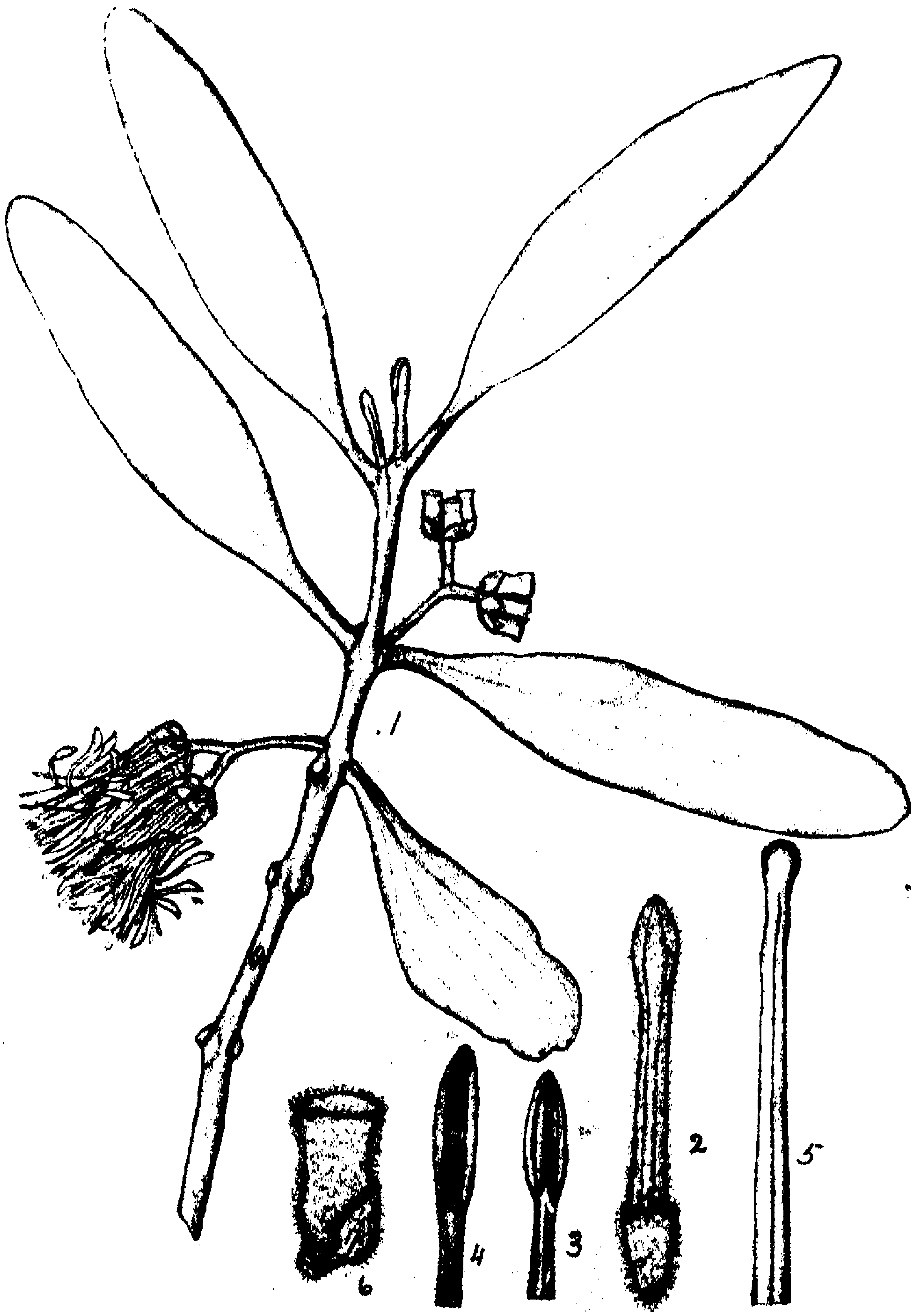
2. *Secotium superbum.*

1. *Secotium melanosporum.* 2. *S. porphyreum.*
3. *S. piriforme.* 4. *S. cartilagineus.*



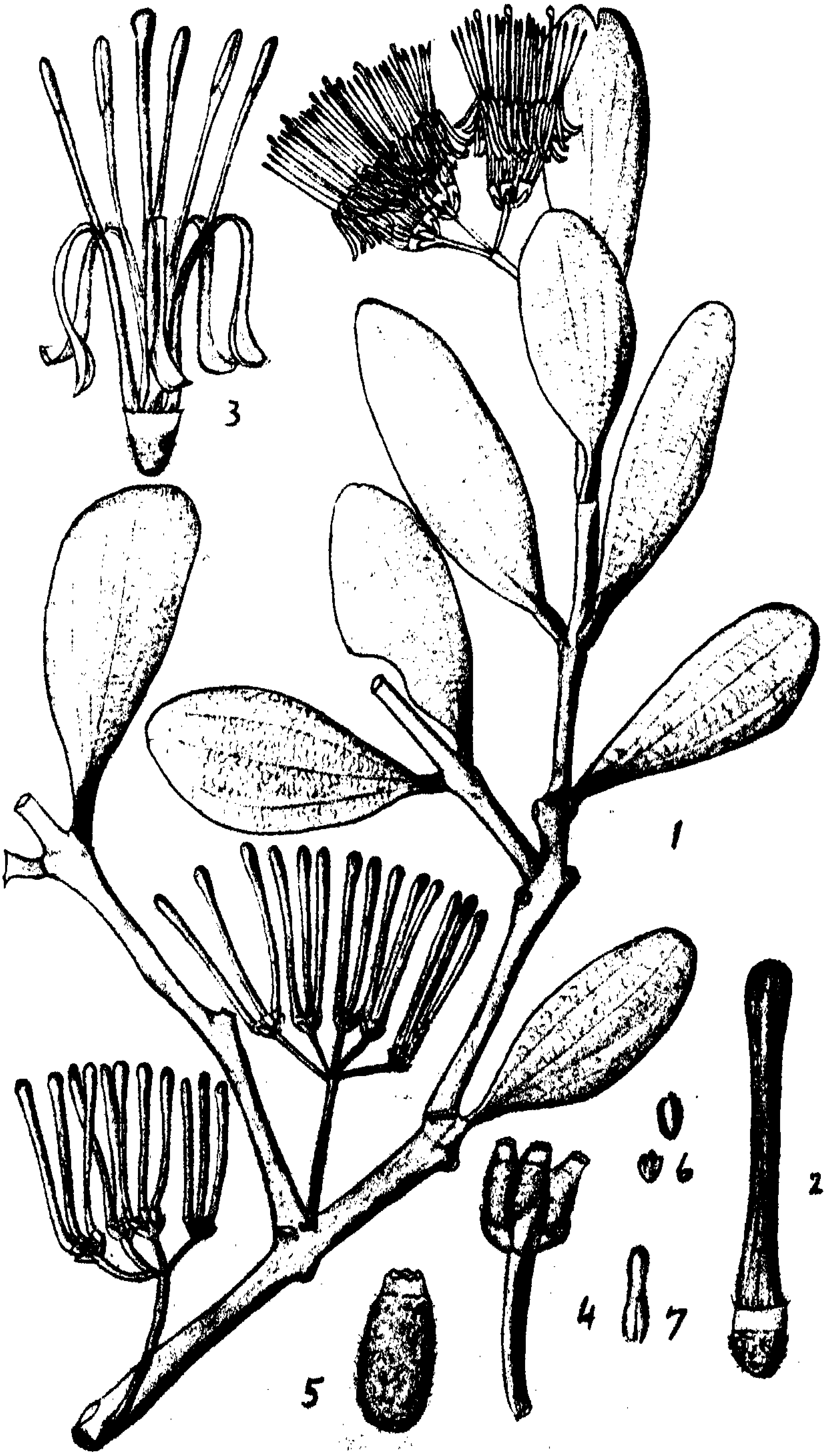
Loranthus Nestor S. Moore.

W.F.B. del.



Loranthus Hilliana, n.sp.

W.F.B. del.

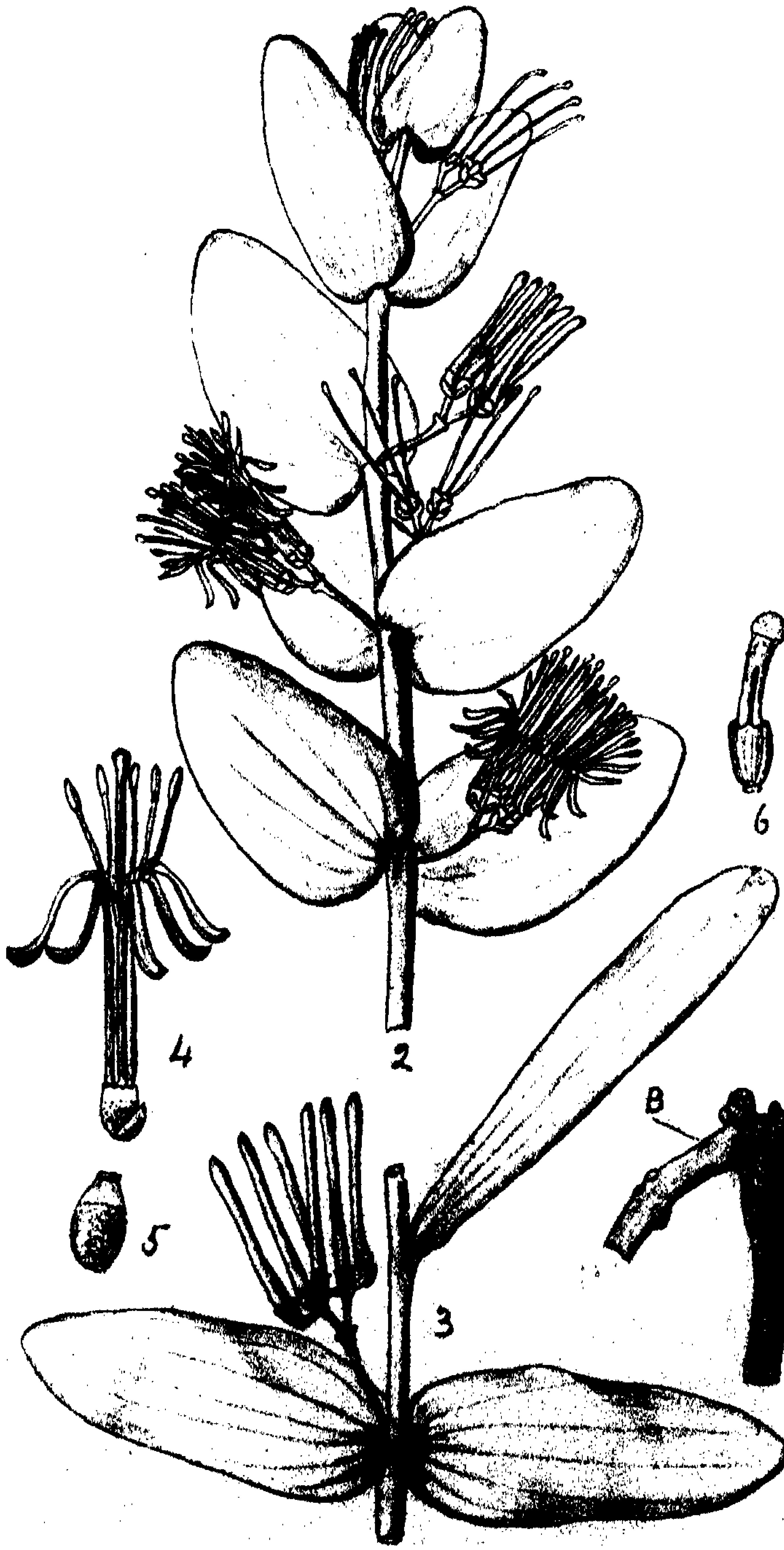


Loranthus Lucasi, n.sp.

W.F.B. del.

Loranthus Quandang Lindl.

W.F.B. del.



Loranthus Benthami, n.sp.

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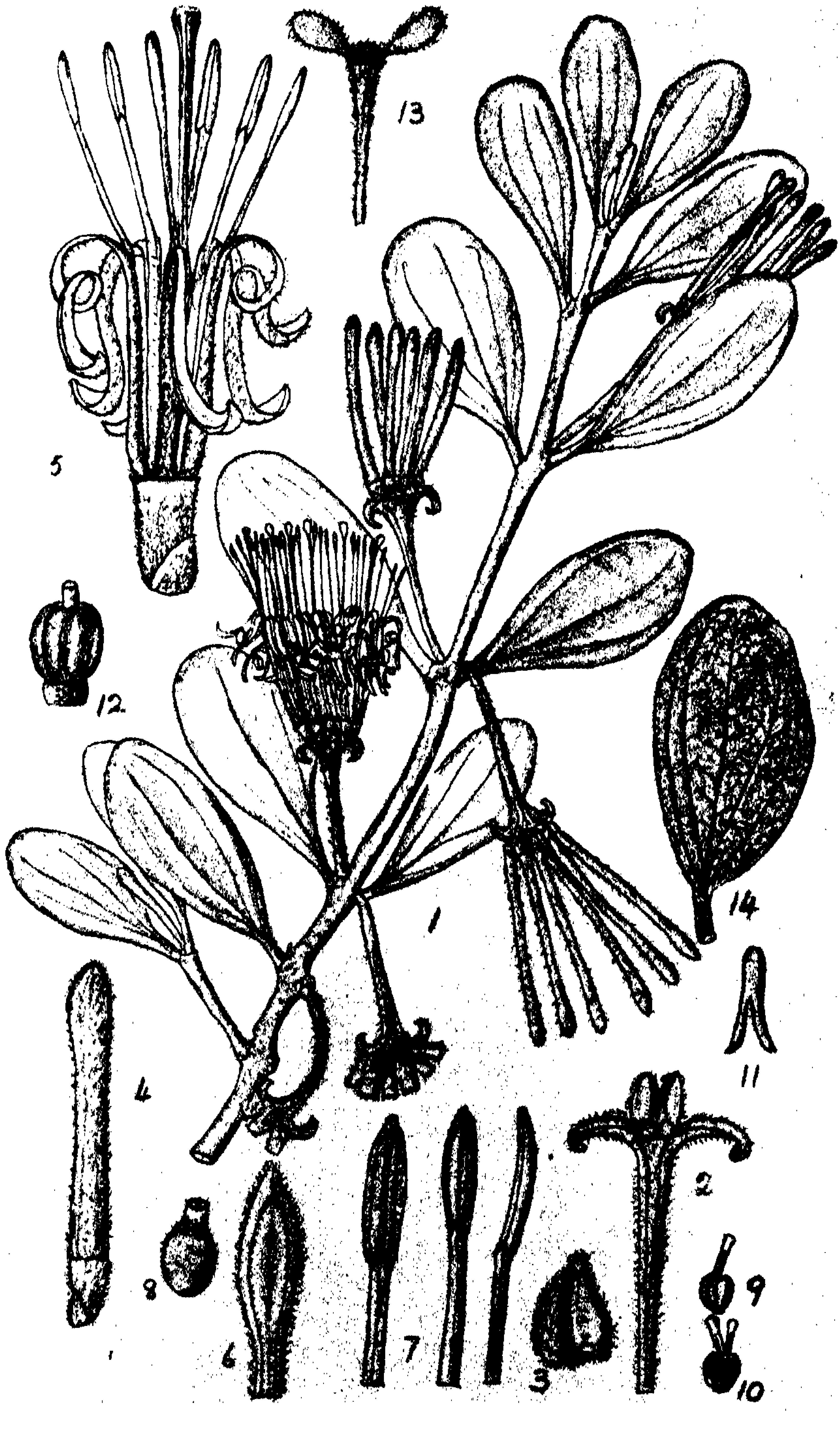

Loranthus Maideni, n.sp.

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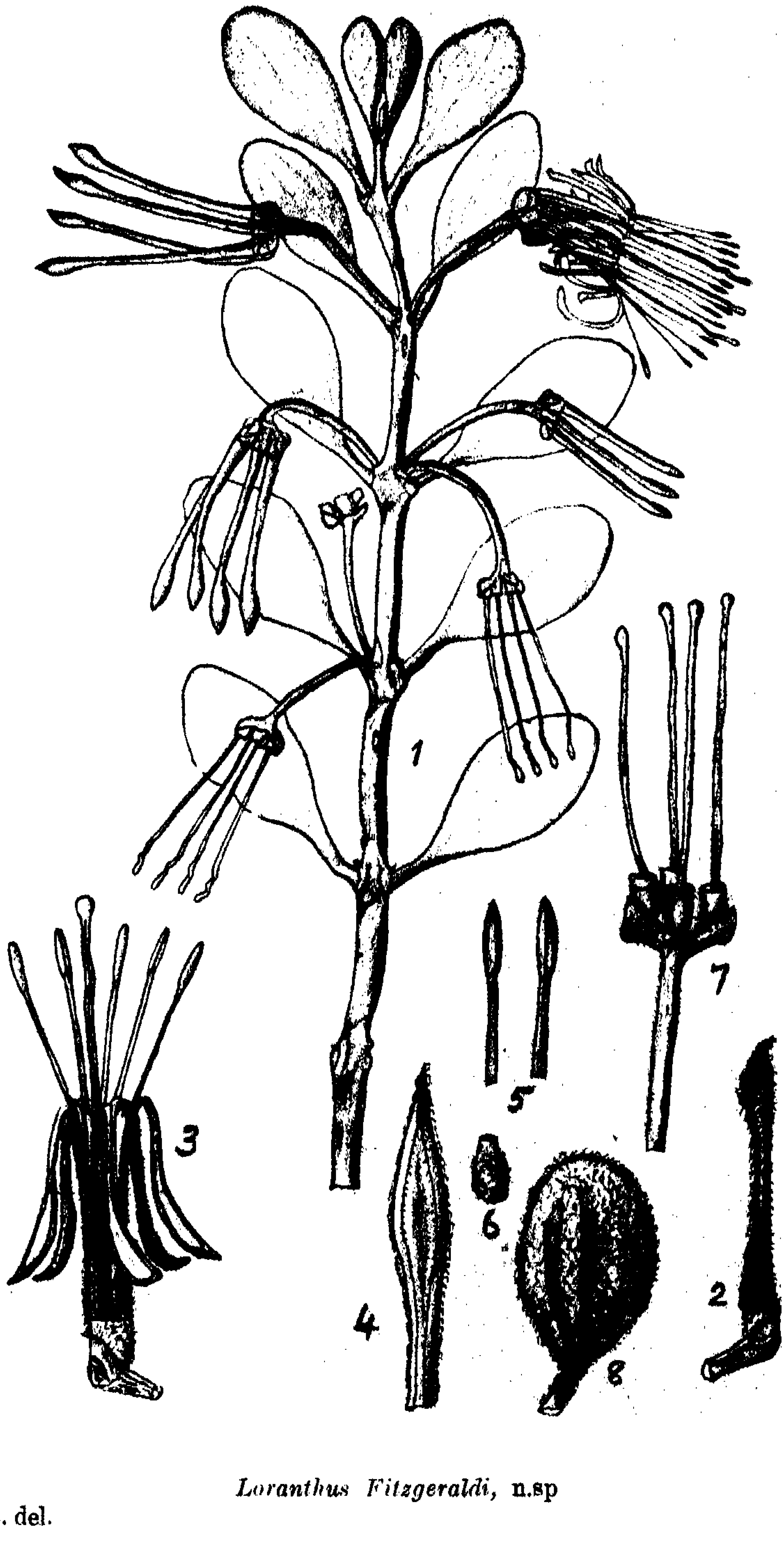

Loranthus Fitzgeraldi, n.sp

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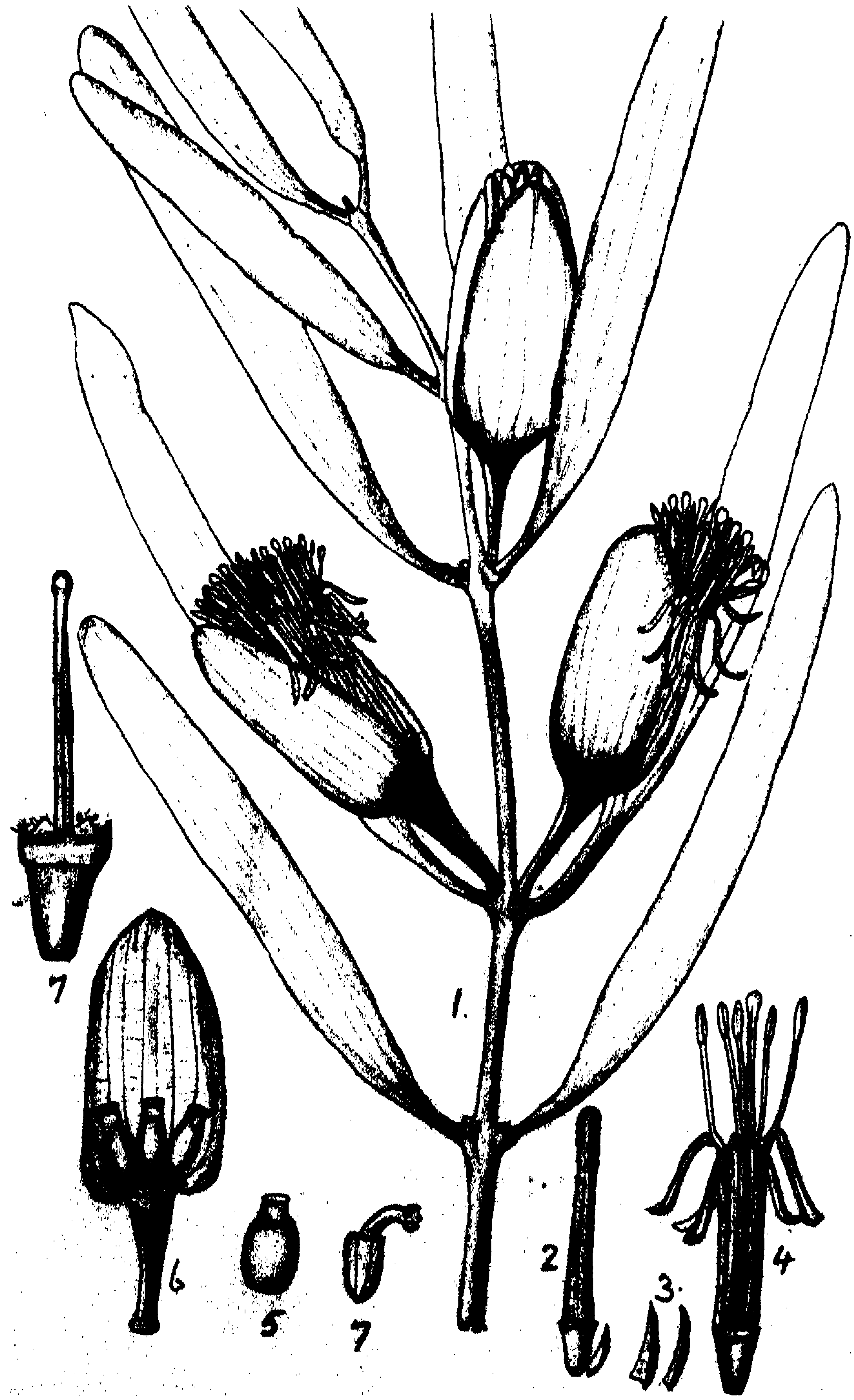

Loranthus grandibracteus F.v.M.

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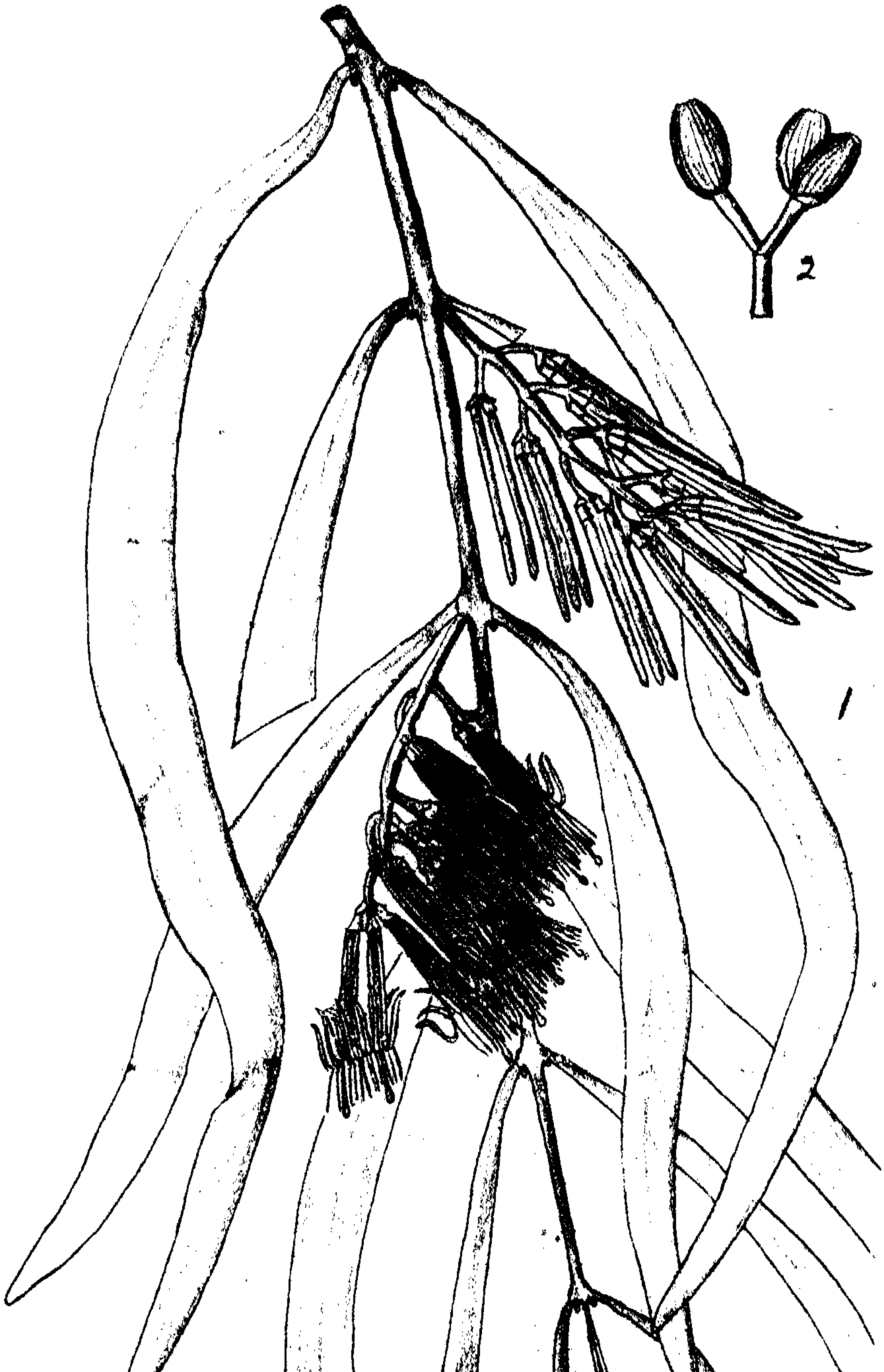

Loranthus Brittenii, n.sp.

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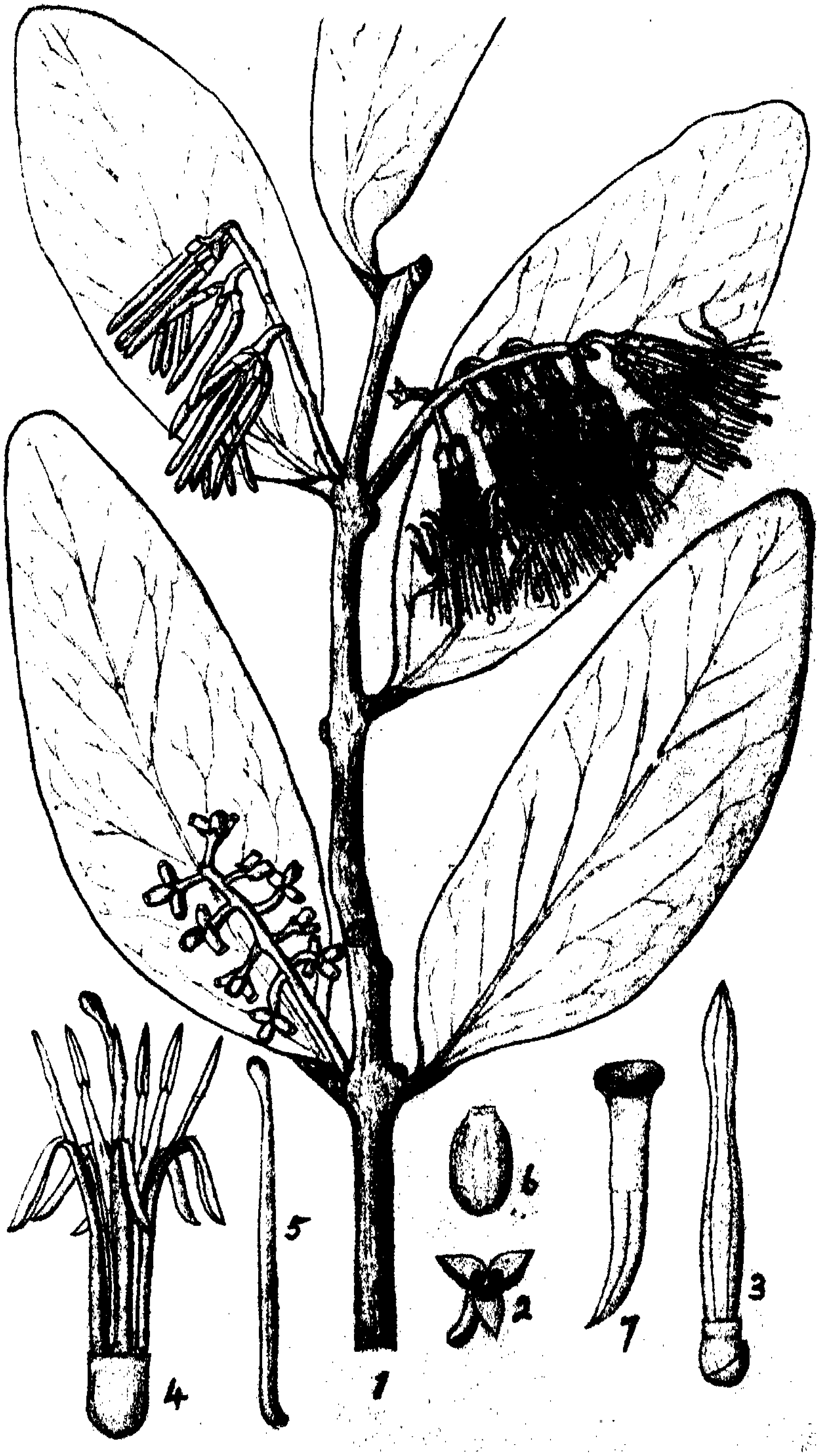
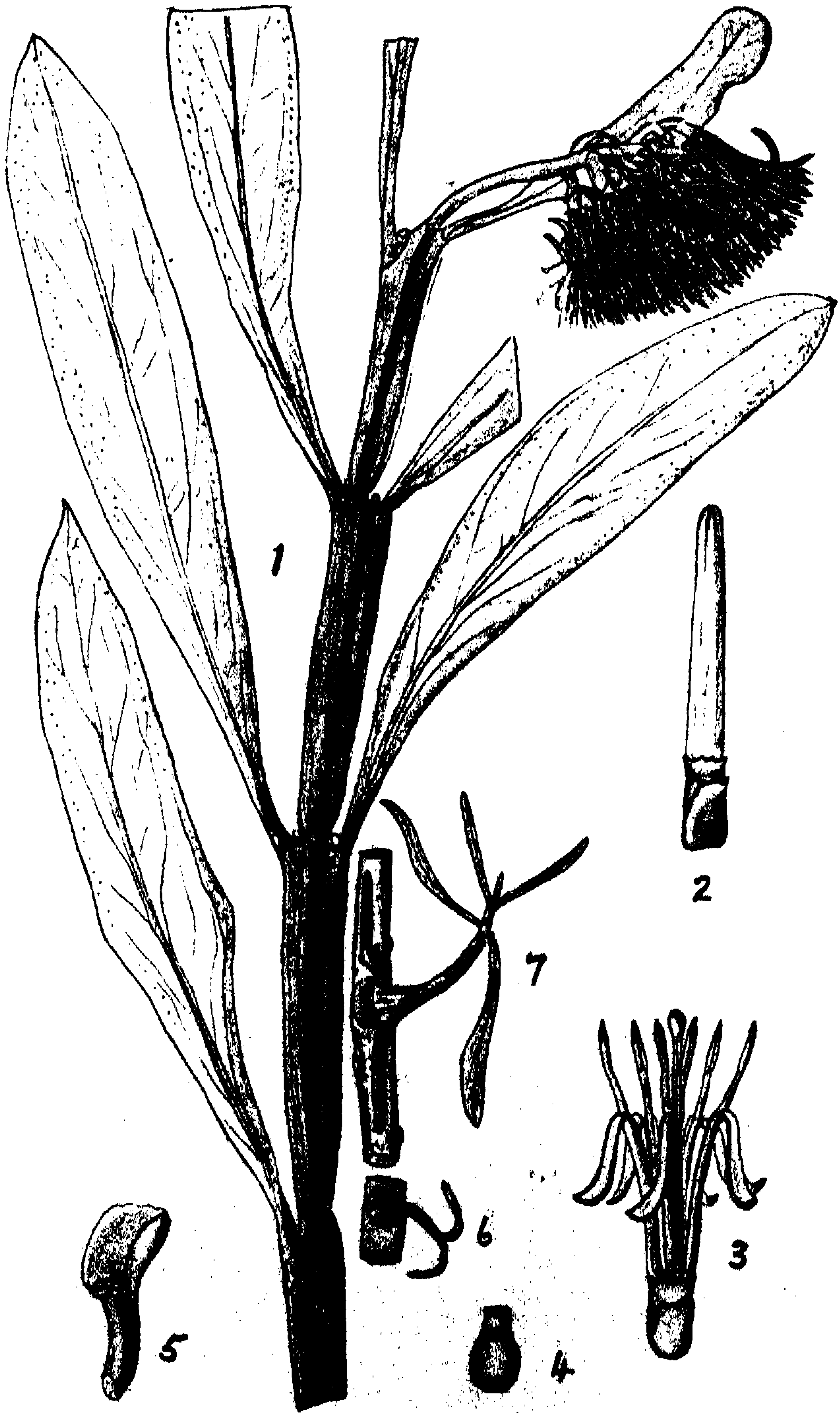


Loranthus signatus F.v.M.

W.F.B. del.

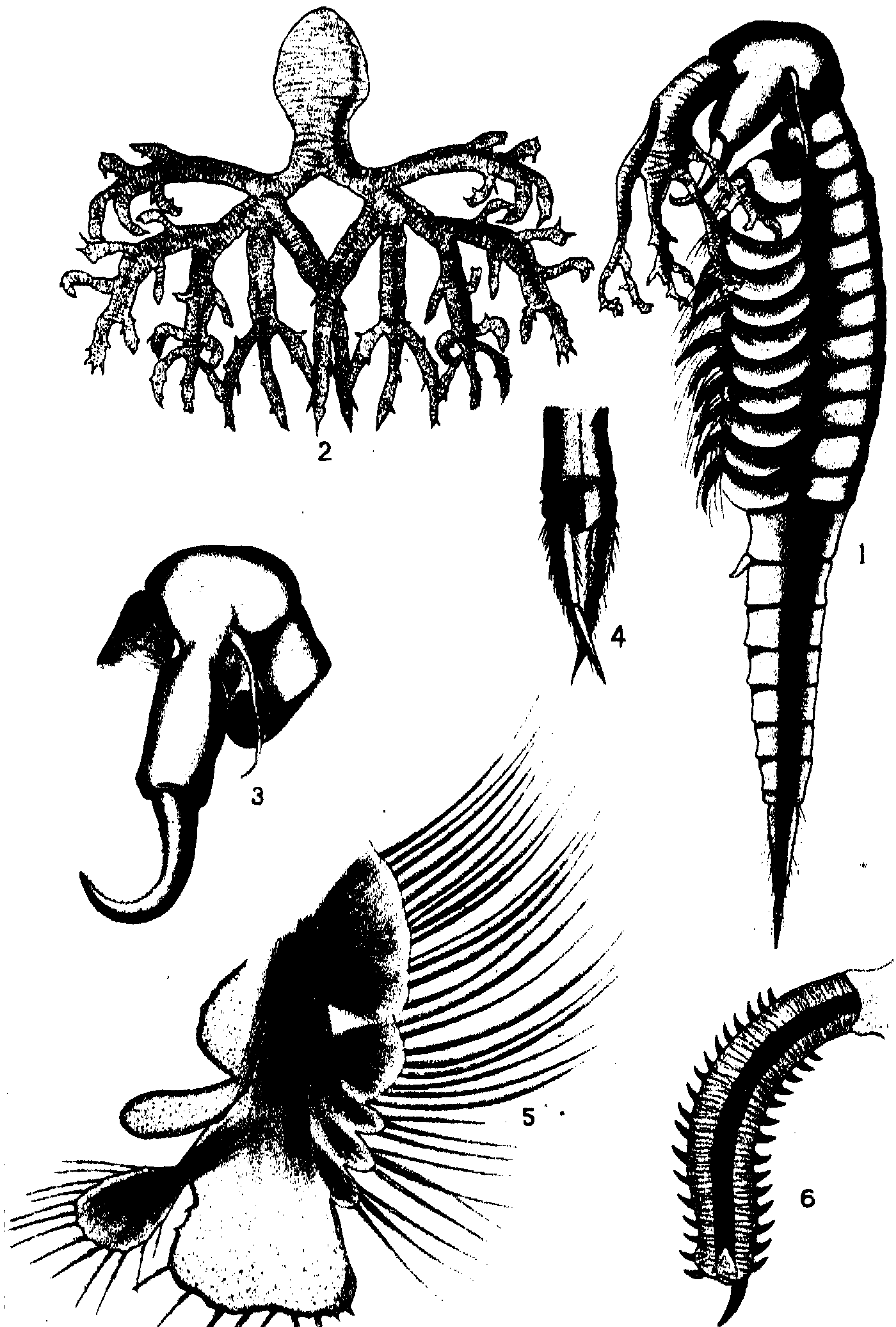
Loranthus amplexans (Van Tiegh.).

W.F.B. del.

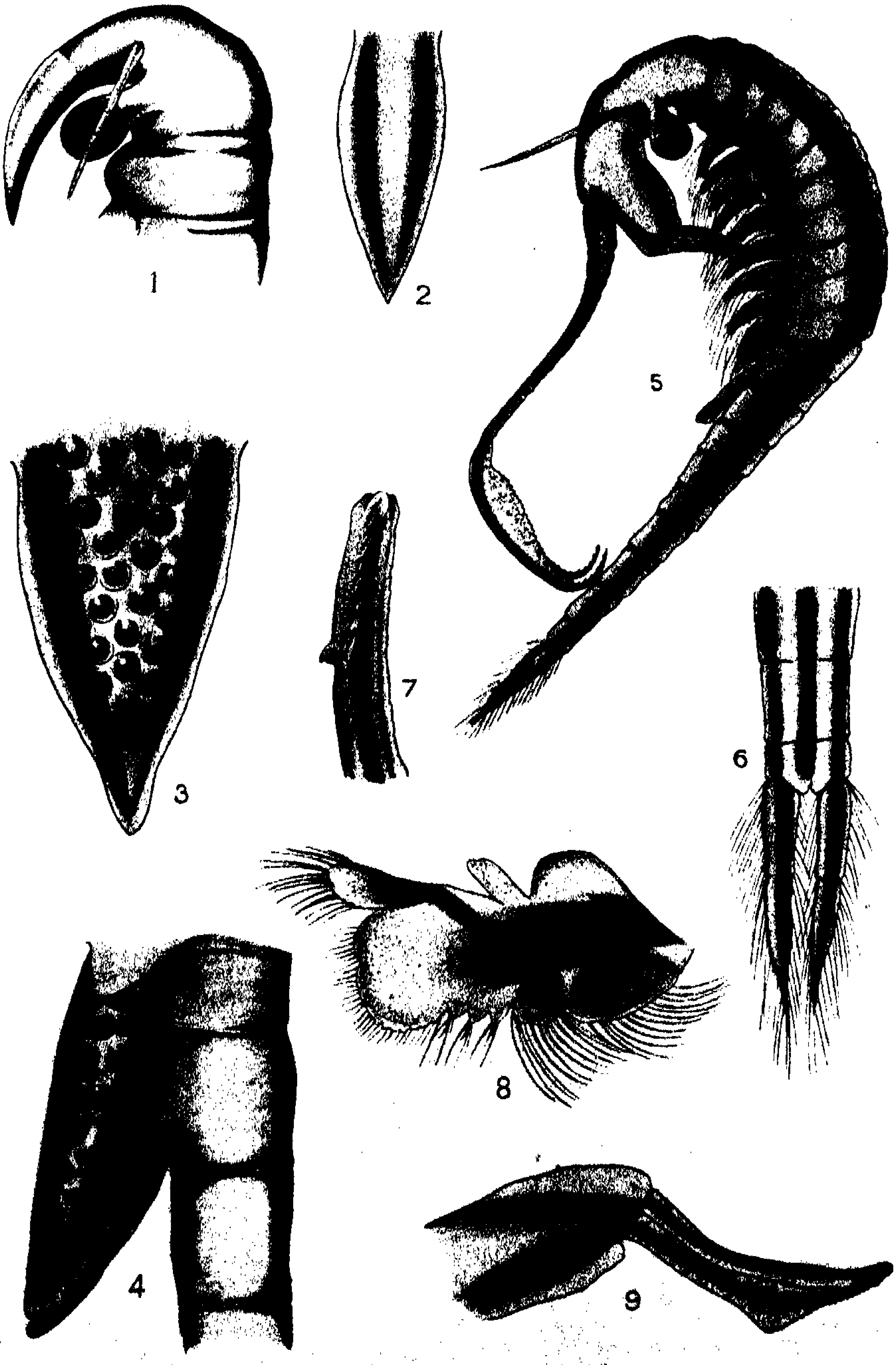


Loranthus biangulatus W. V. Fitz.

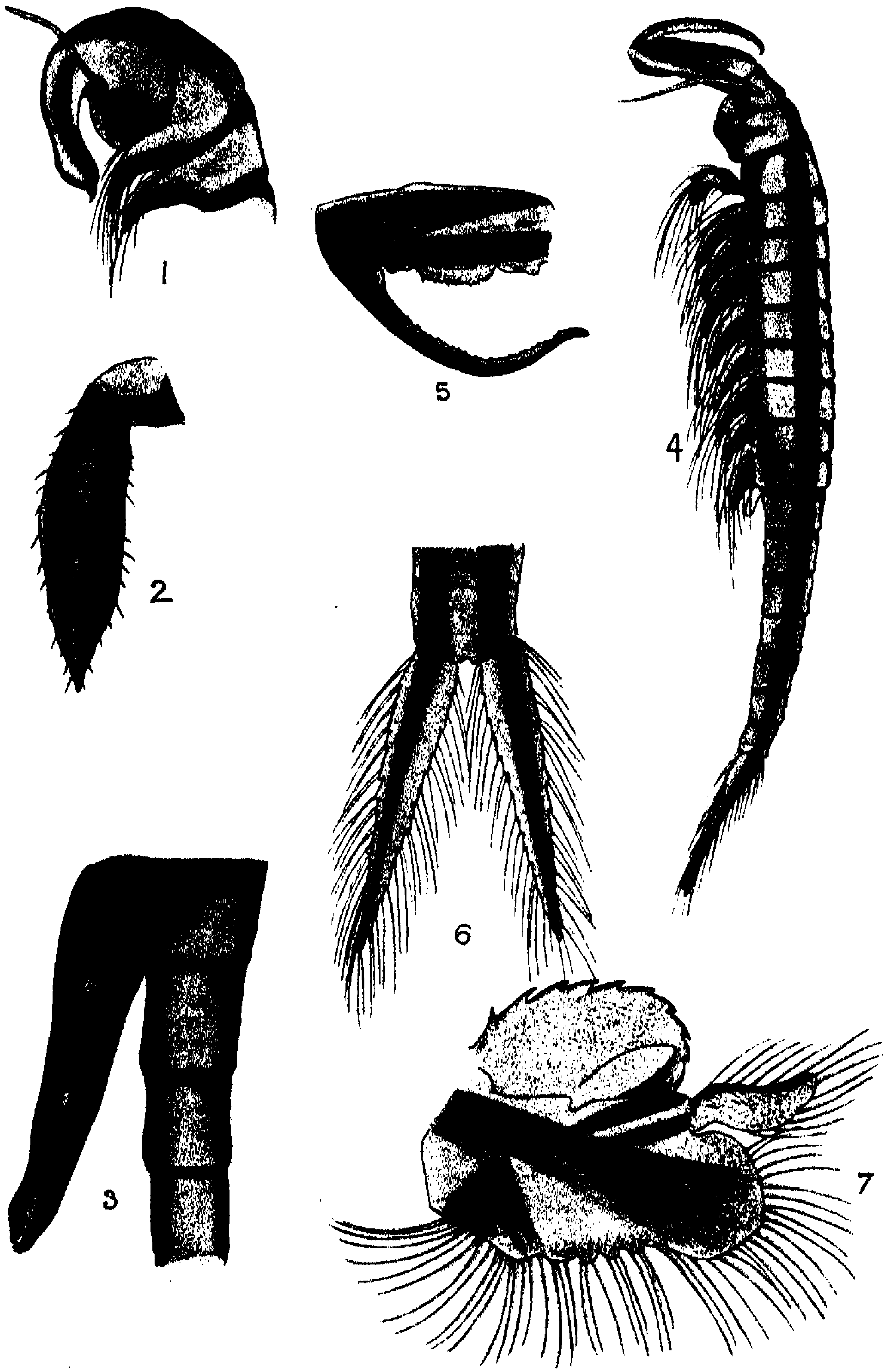
W.F.B. del.



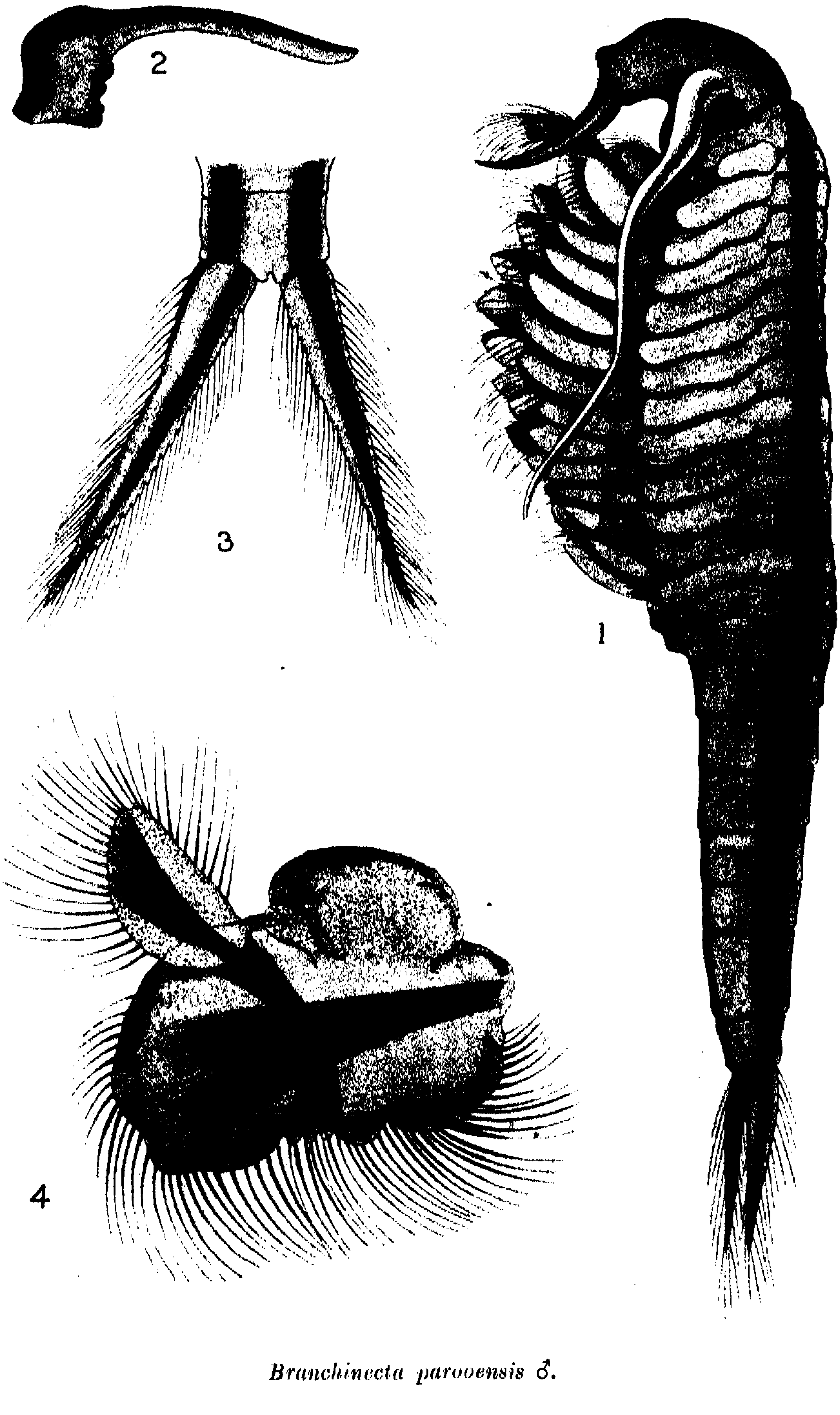
Branchinella frondosa ♂.



1-4. *Branchinella frondosa* ♀. 5-9. *B. proboscida* ♂.

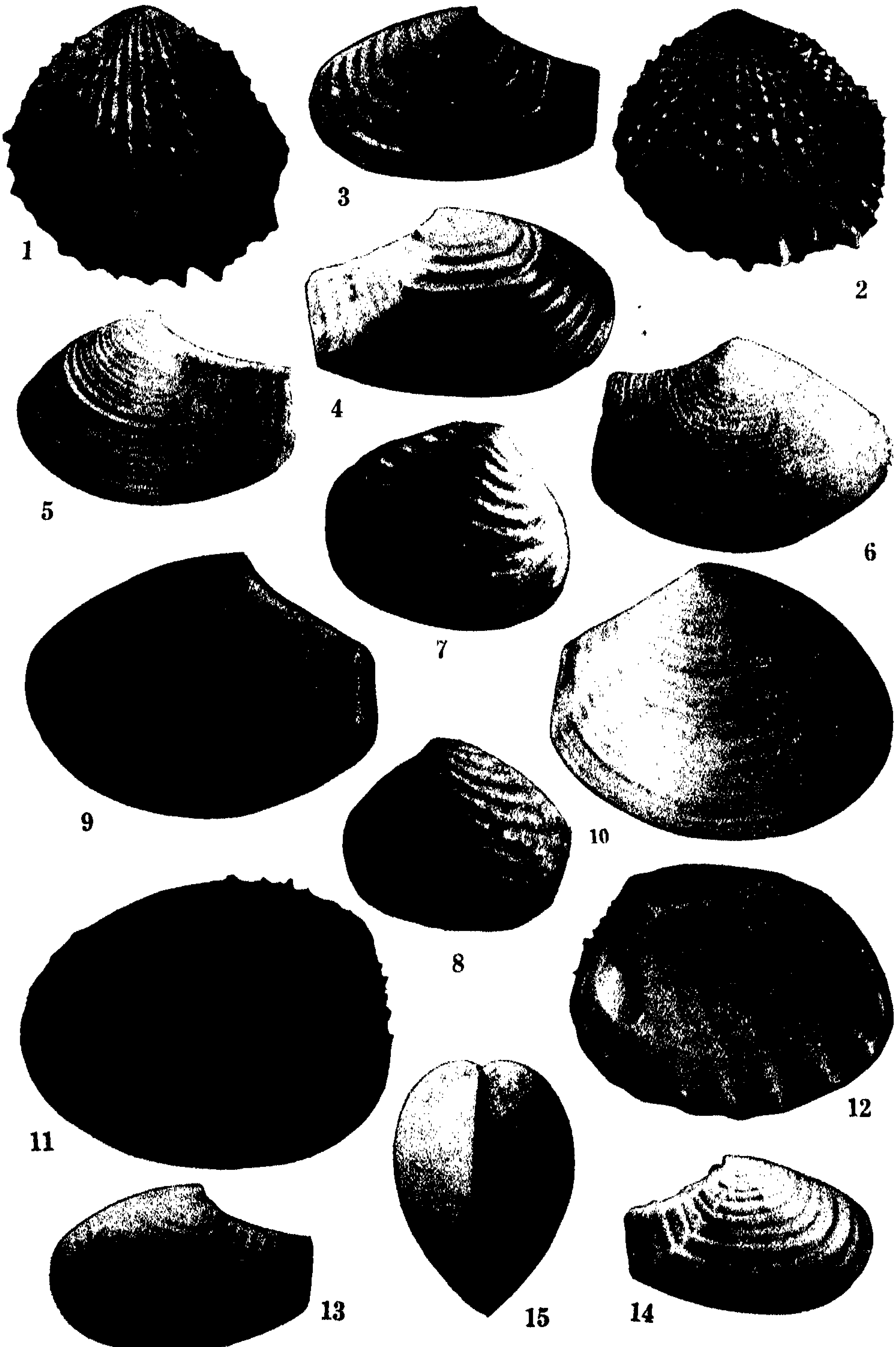


1-3. *Branchinella proboscida* ♀. 4-7. *Branchinecta tenuis* ♂.

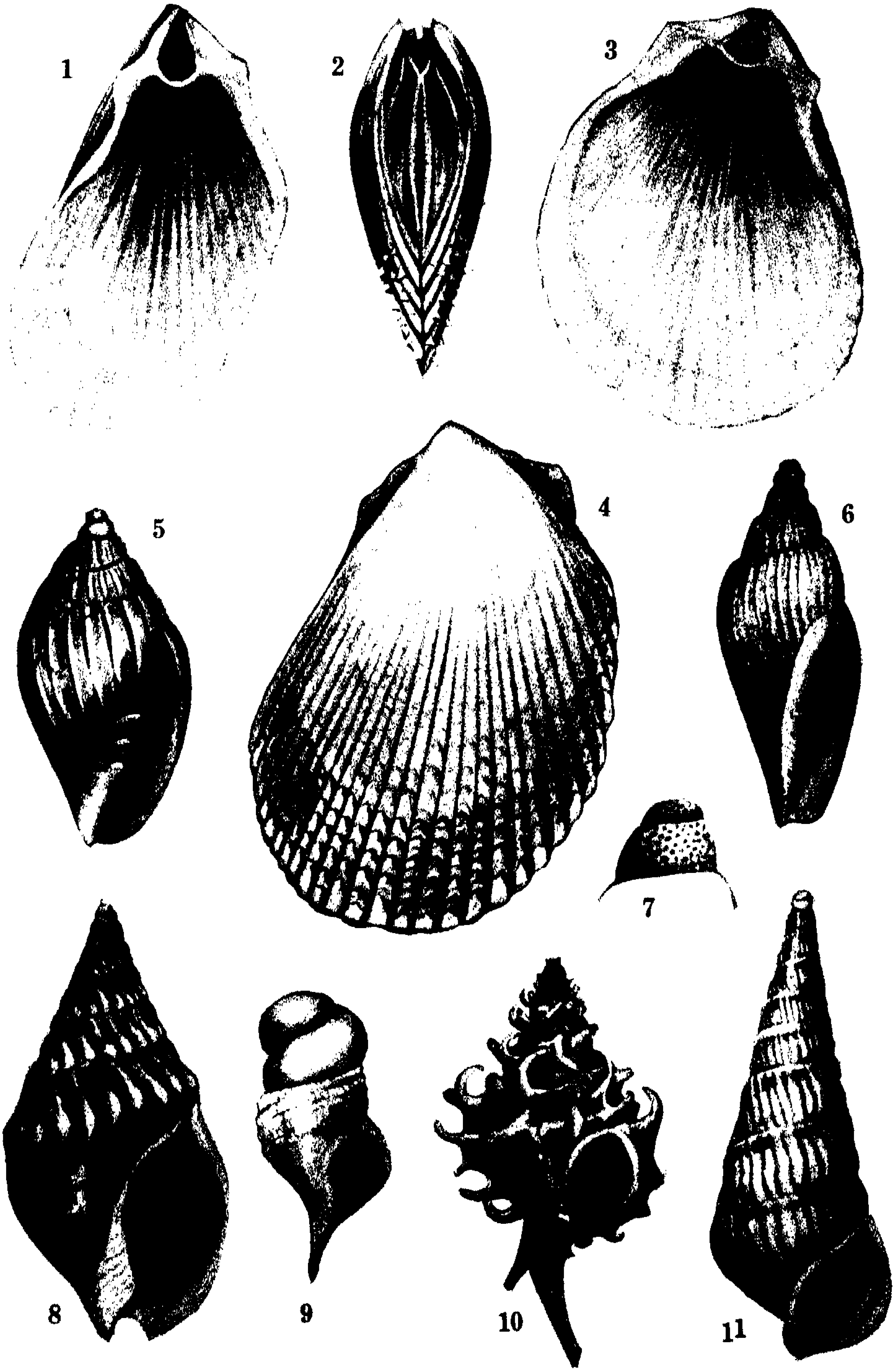


Branchinecta parooensis ♂.

1-7. *Limnadopsis parvispinus* 8-9. *Estheria rubra.*



Mollusca from Roy Bell's Collections.



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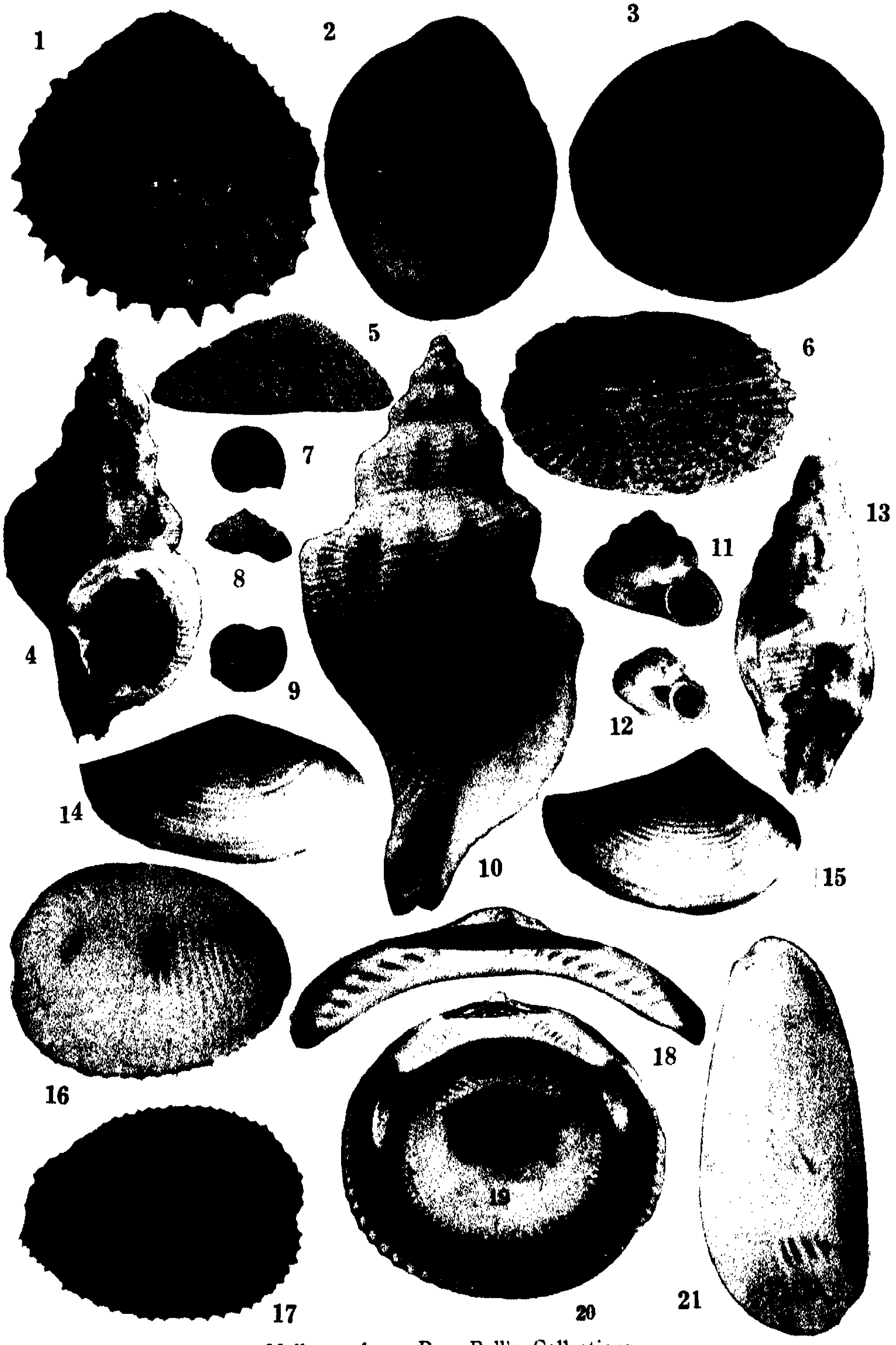

Mollusca from Roy Bell's Collections.

Mollusca from Roy Bell's Collections.

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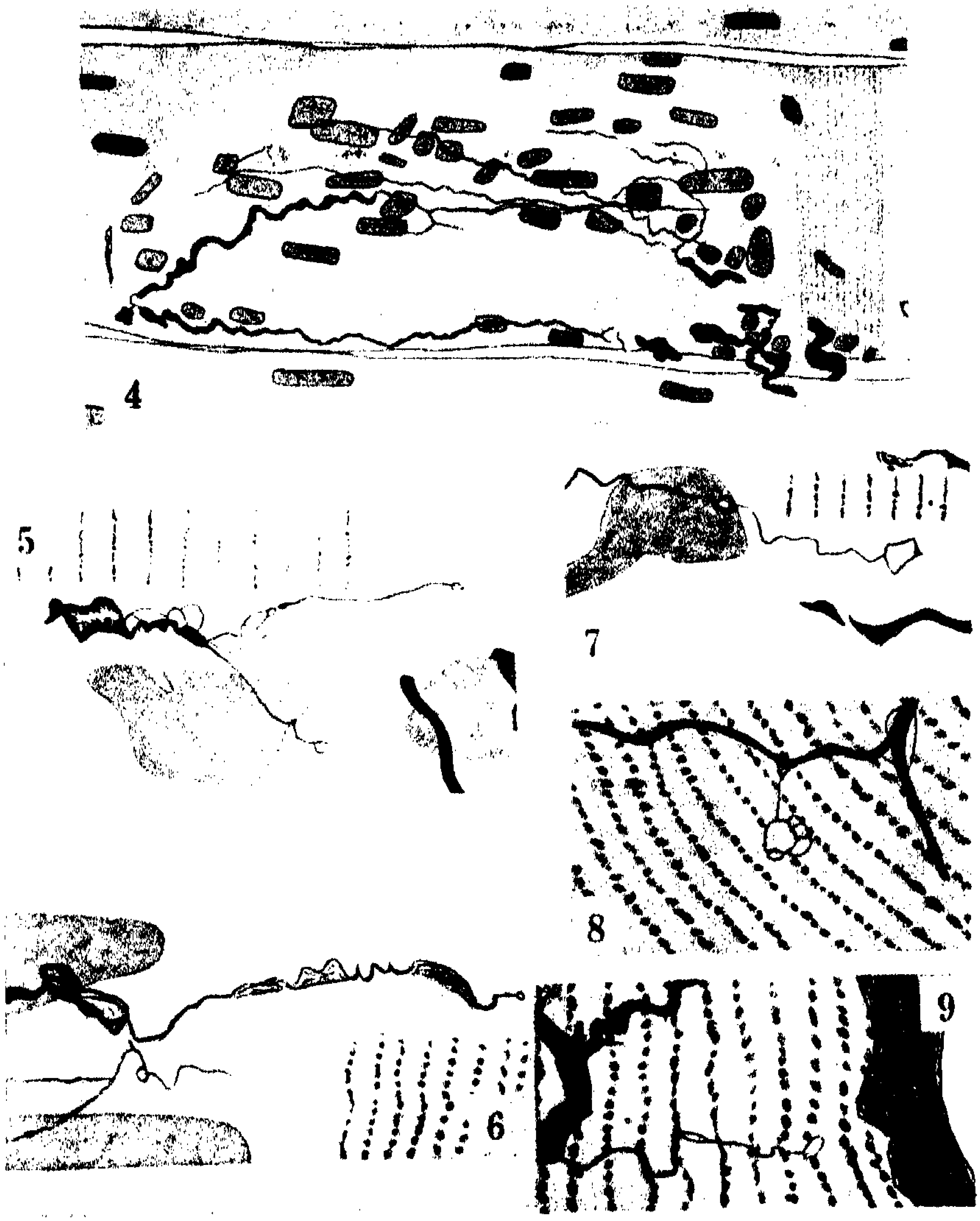
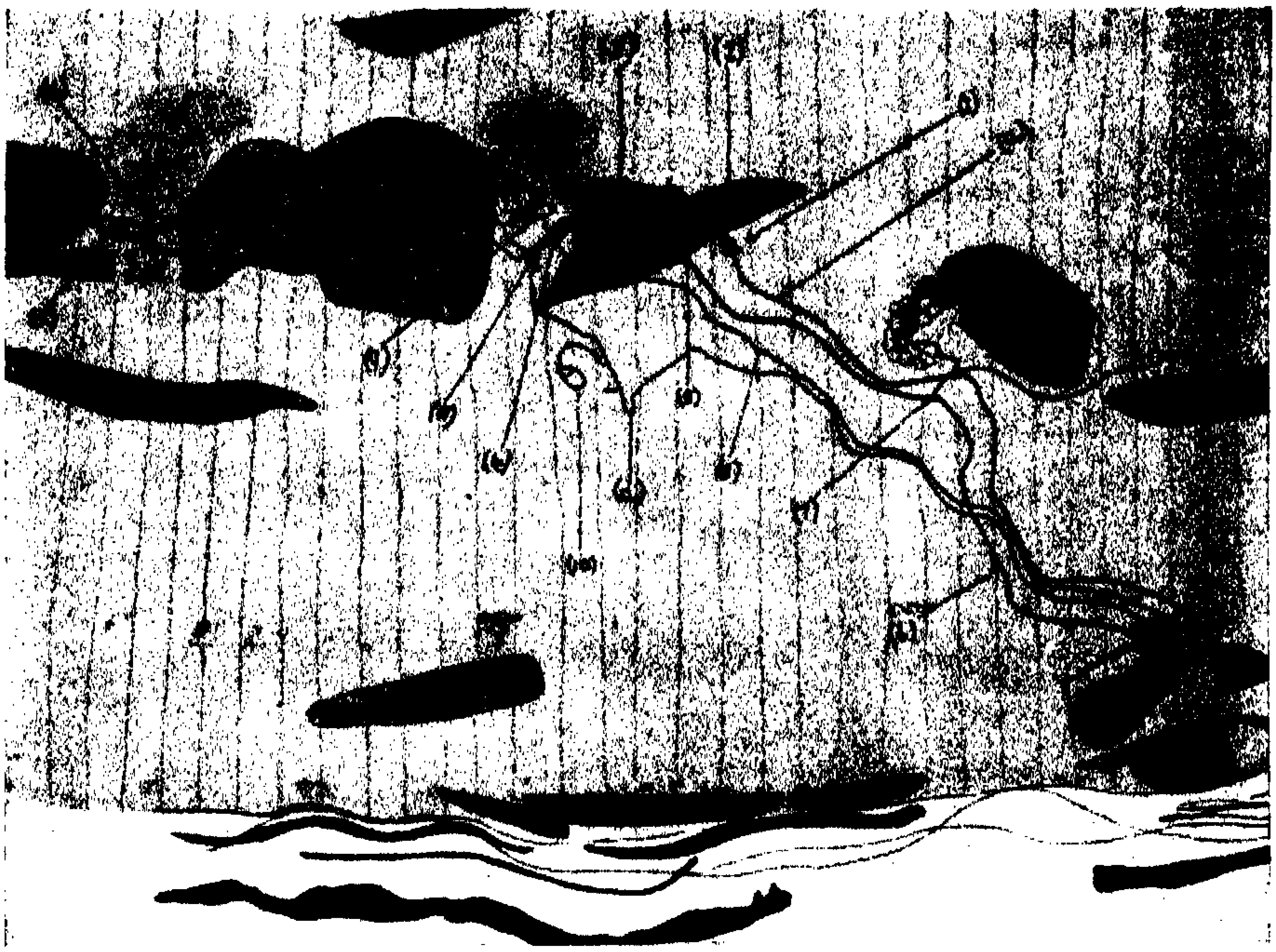
3

Motor nerve-endings in limb muscle of frog. Coarse Type.



Motor nerve-endings in limb muscle of frog.

10



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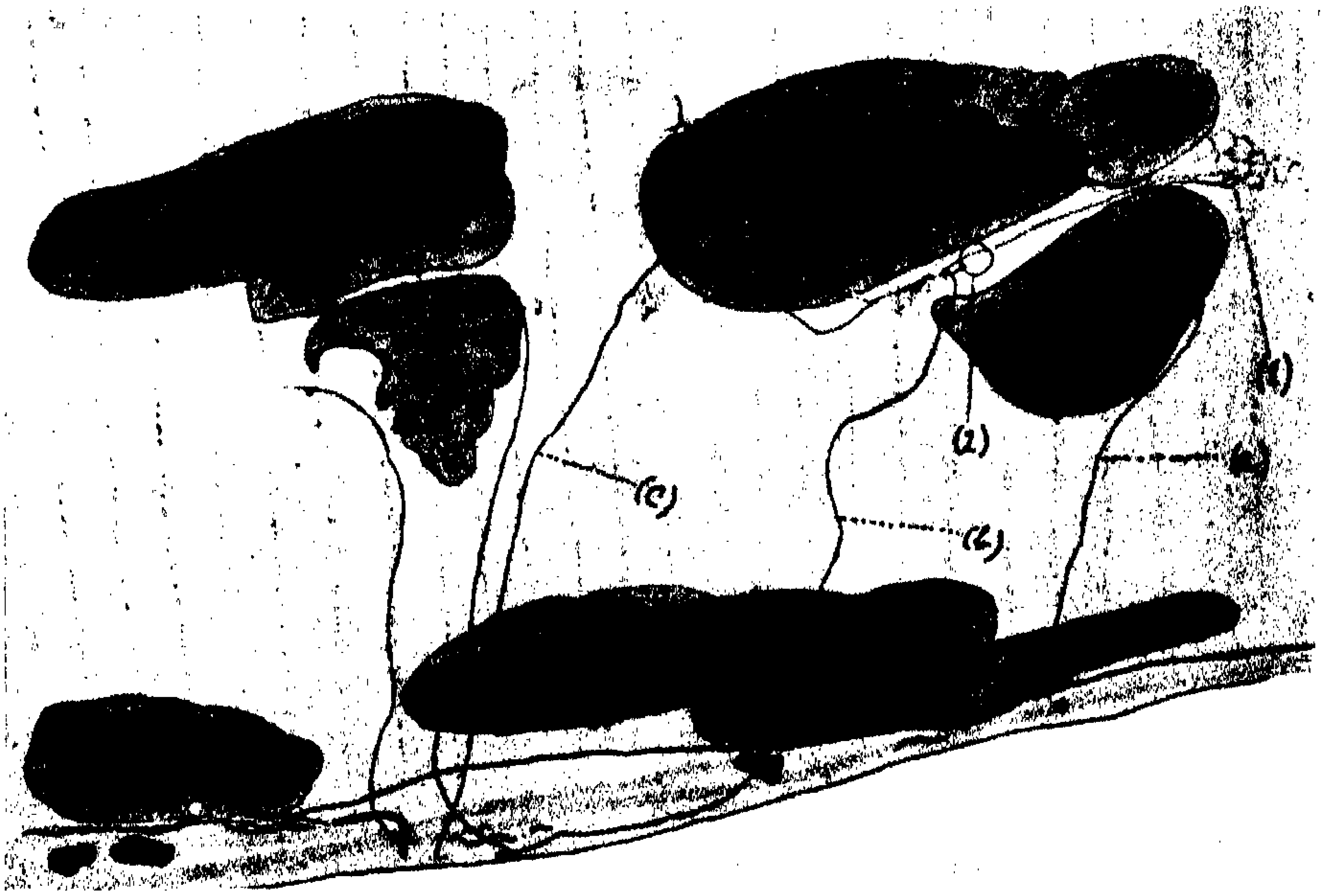
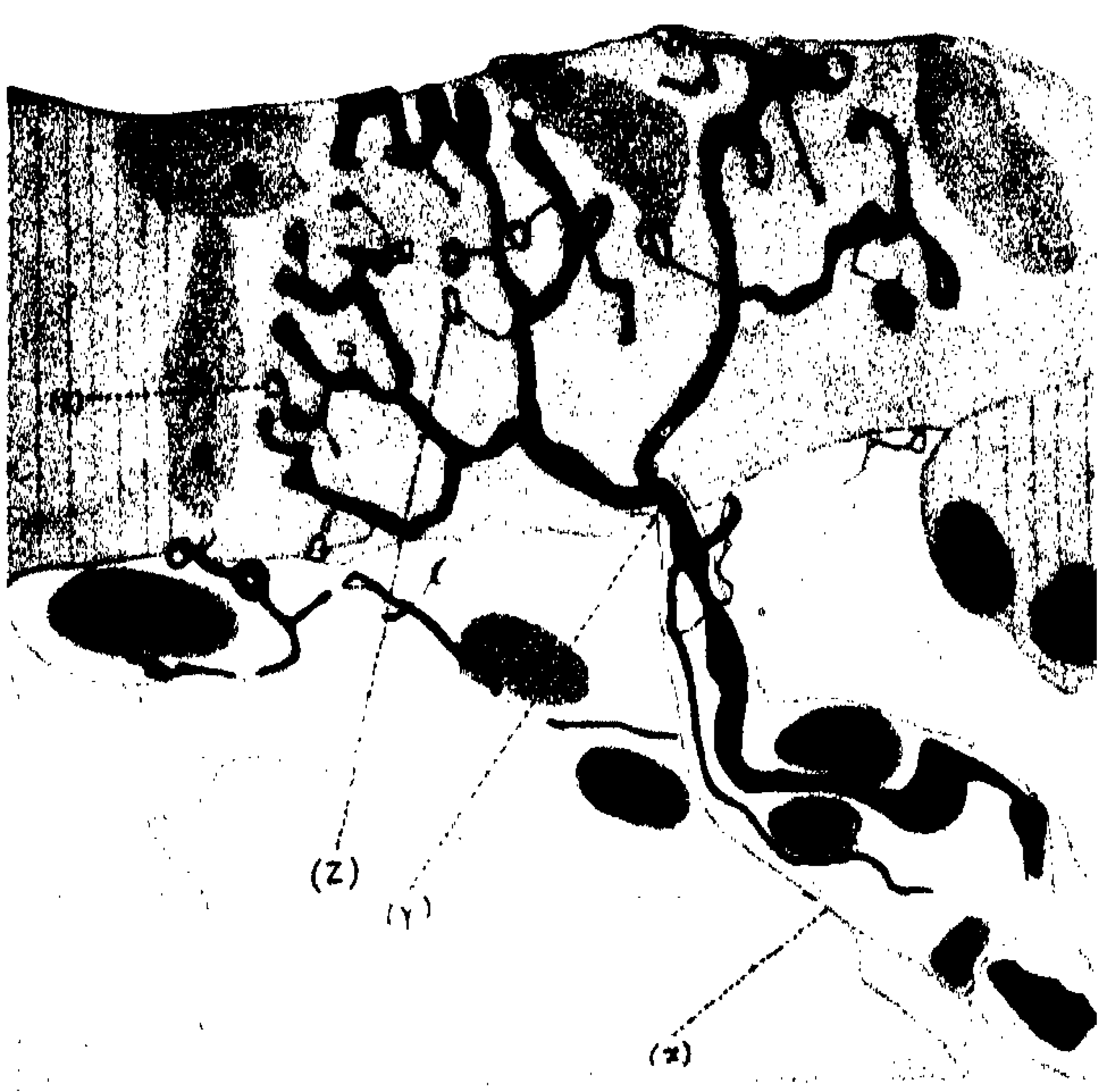


Motor nerve-ending in limb muscle of frog. Fine type.

12

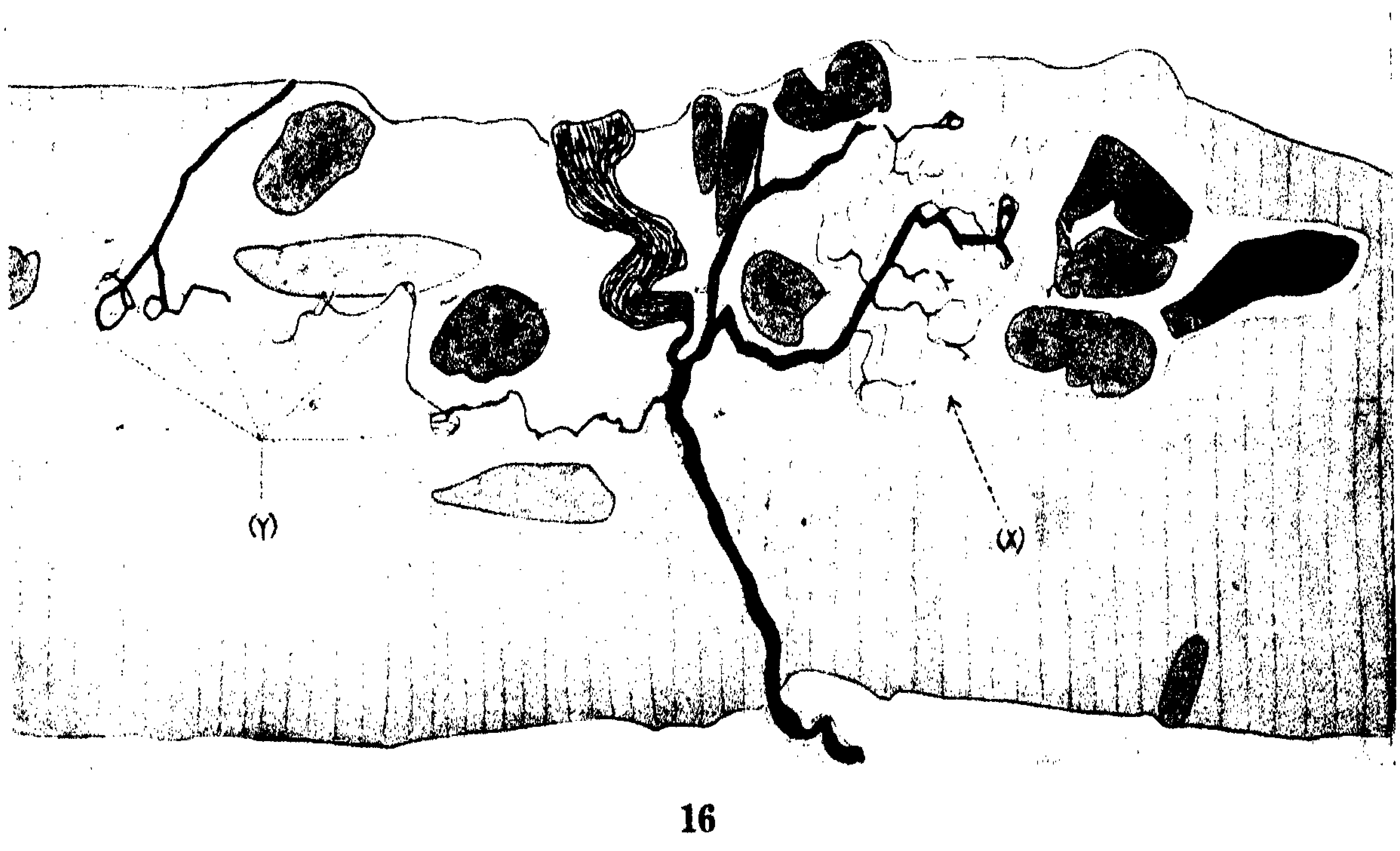
13

14



12, 13. Motor nerve-ending in limb muscle of frog.
14. Motor nerve-ending in muscles of pectoral fin of *Squalus acanthias*.

15



16

Motor nerve-endings in muscles of pectoral fin of *Squalus acanthias*.

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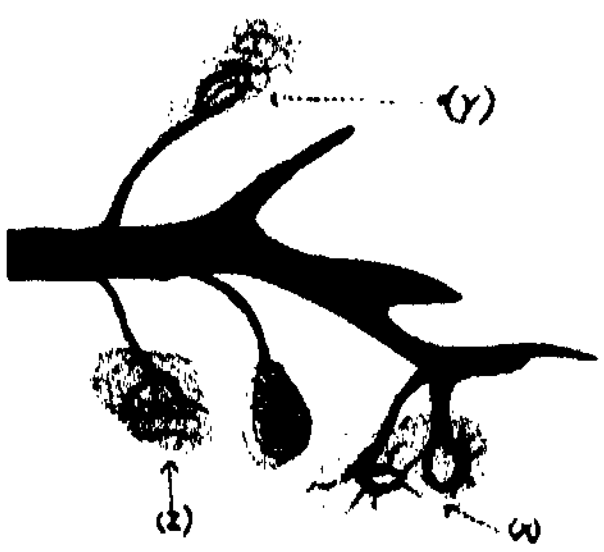
Motor nerve-endings in muscles of pectoral fin of *Squalus acanthias*.

20



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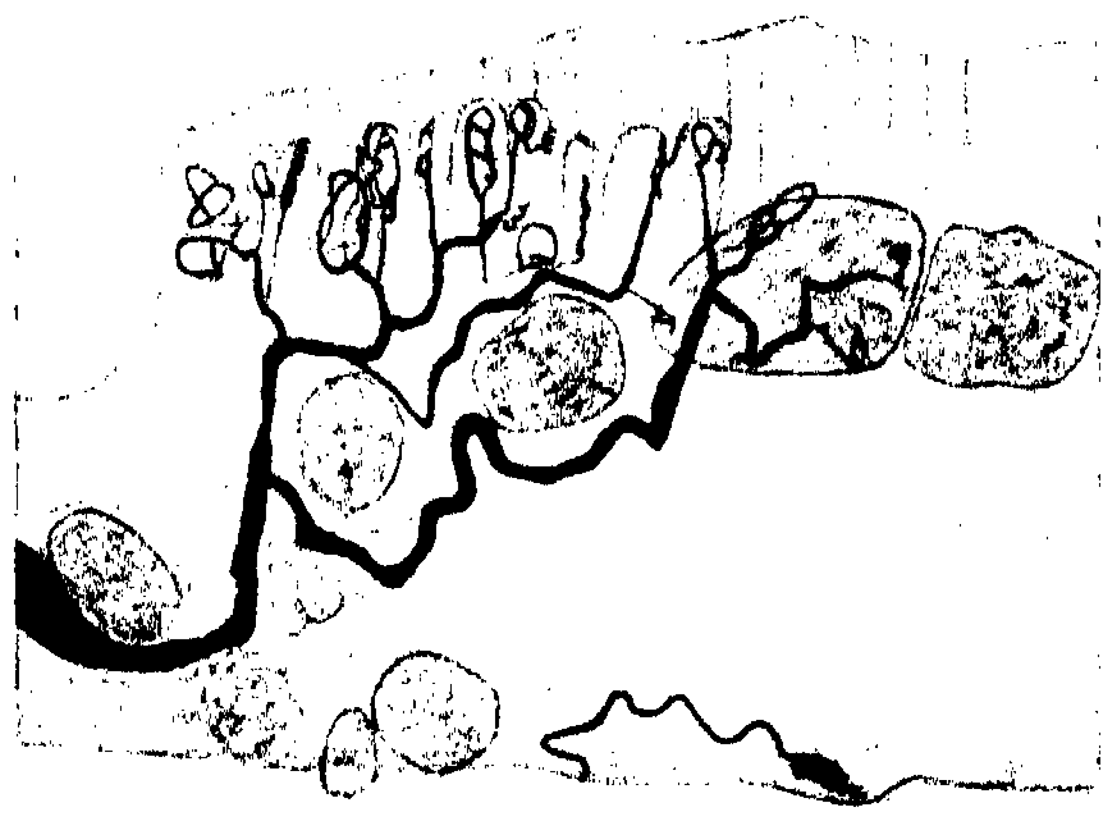

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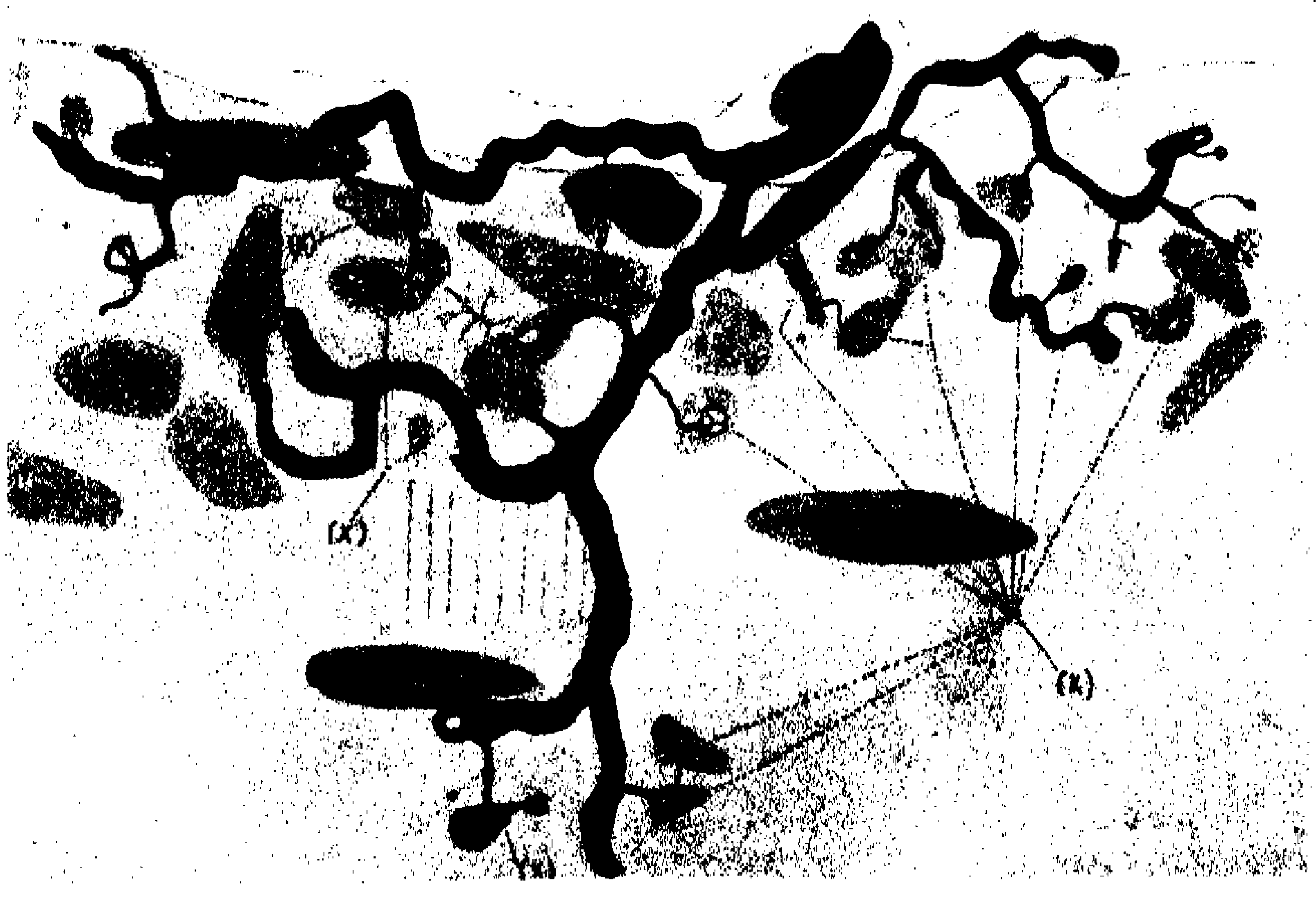
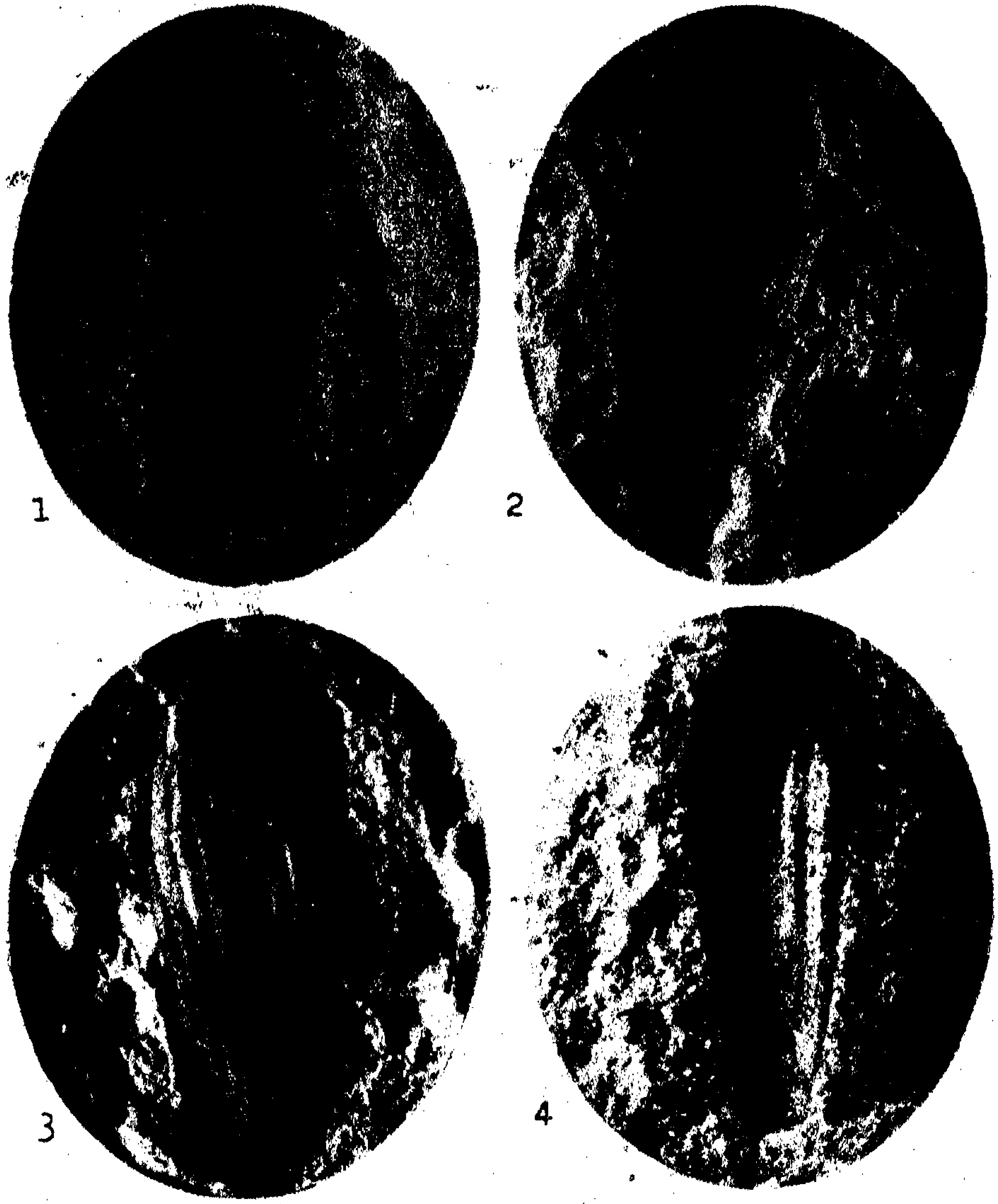


23

Motor nerve-endings in muscles of pectoral fin of *Squalus acanthias*.

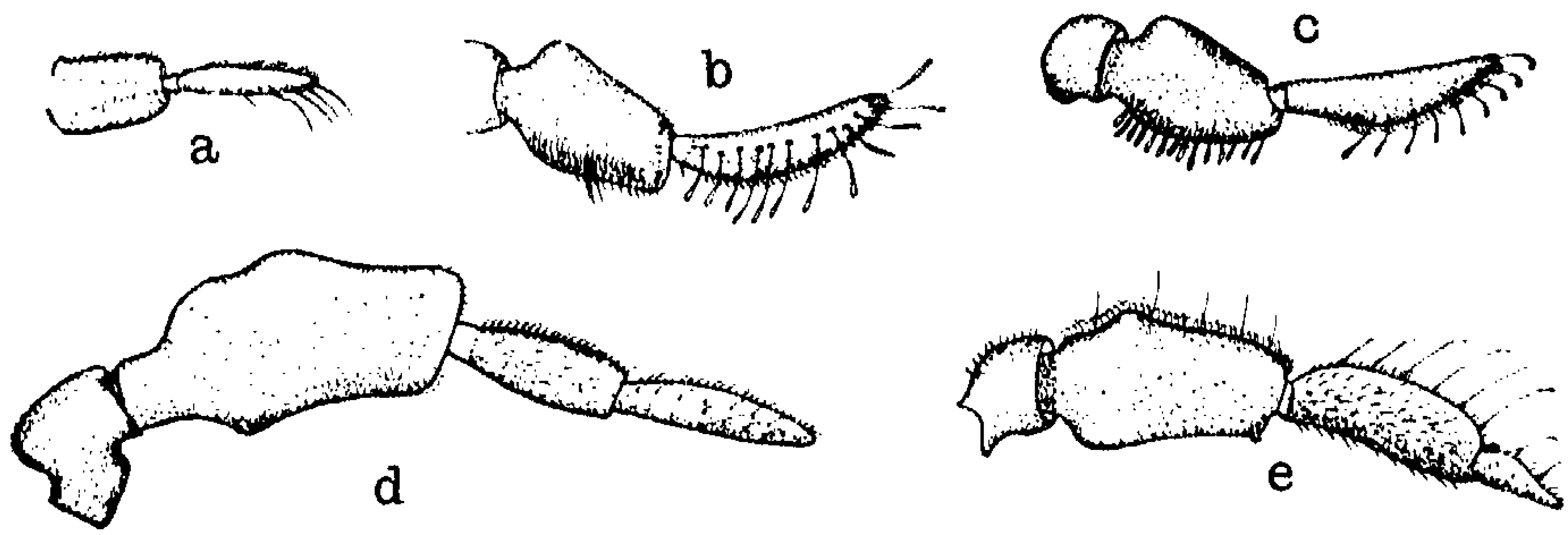
Eucalyptus stricta injured by species of *Eriophyes*. (x ½).



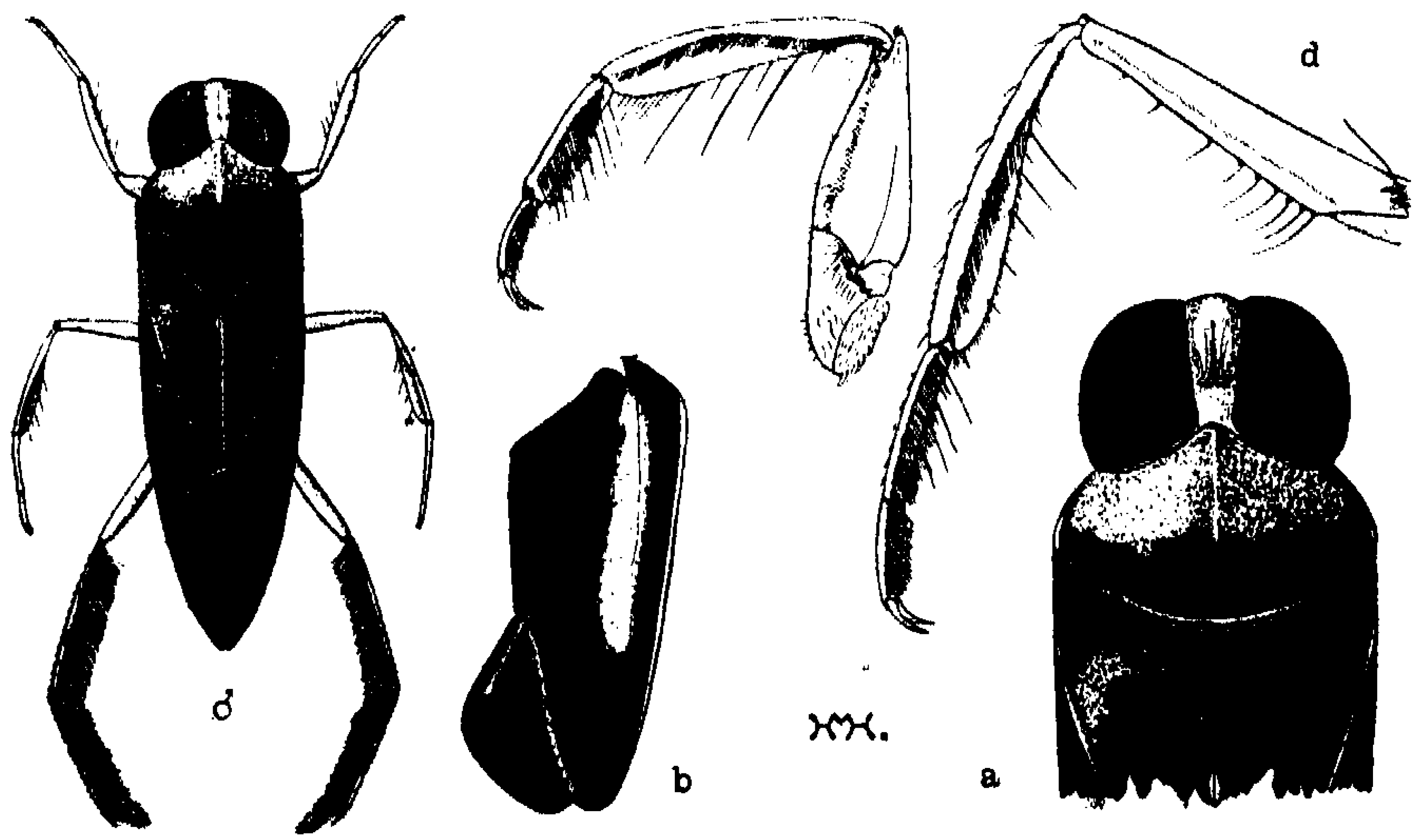
Species of *Permosyne*, n.g.

1. *P. belmontensis*. 2. *P. affinis*.
3. *P. mitchelli*. 4. *P. pincombeae*.

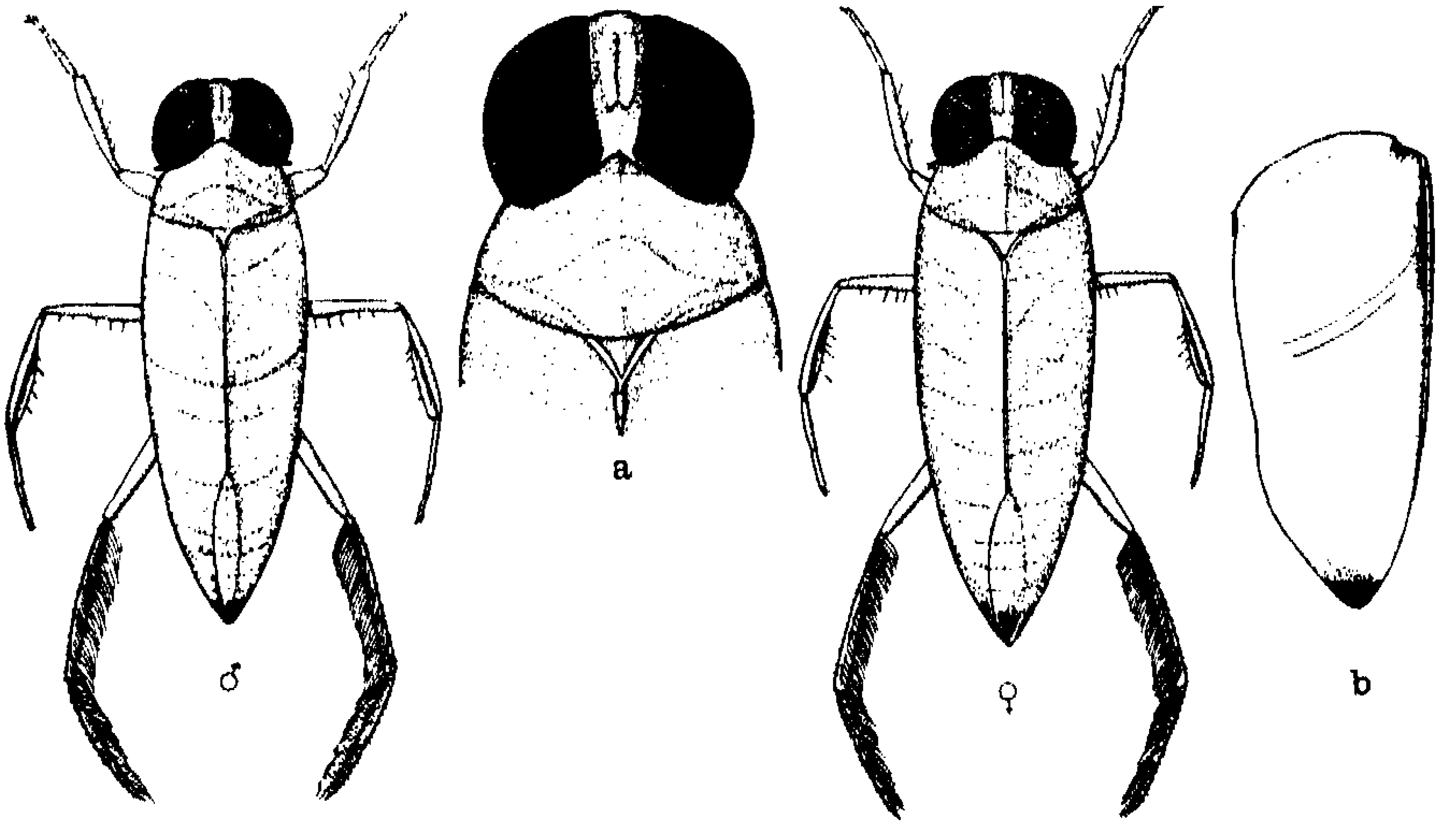
Protocoleus mitchelli, n.g. et sp.



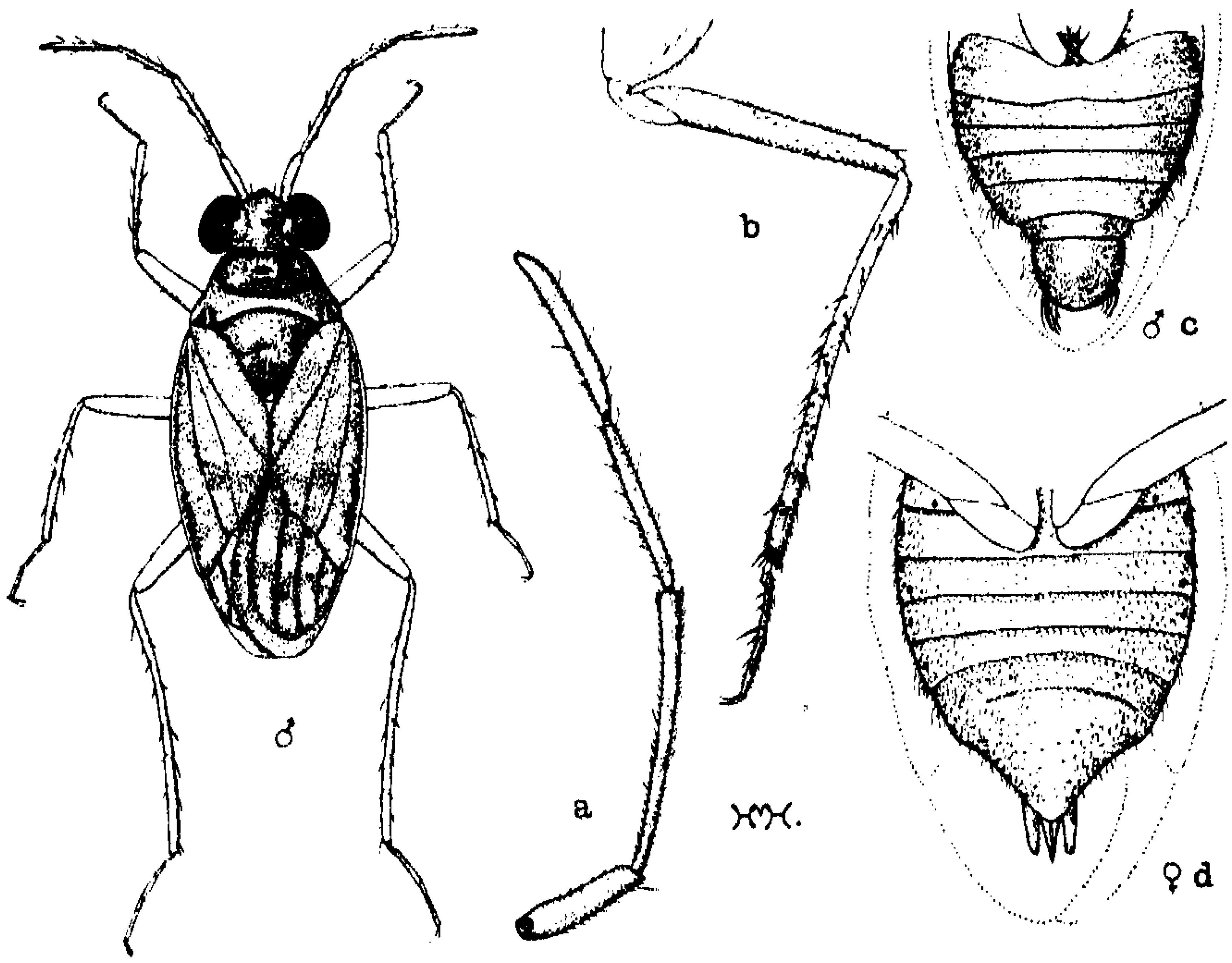
1. Antennae of Notonectinae. a, *Nychia* (scape not shown); b, *Paranisops*; c, *Anisops*; d, *Enithares*; e, *Notonecta*. (All enlarged 50 diams.).



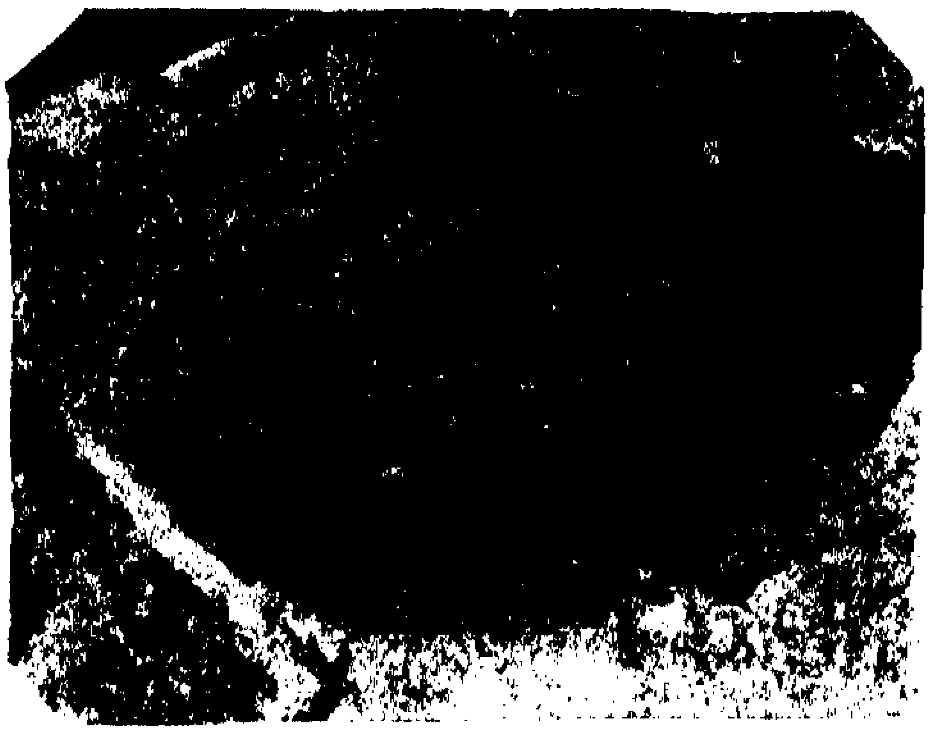
2. *Paranisops inconstans*, male of melanochroic form. a, head and thorax; b, hemelytron; c and d, anterior and intermediate legs.



3. *Paranisops inconstans,* male and female of leucochroic form. a, head and thorax of male; b, hemelytron.



4. *Salda nicholsoni.* a and b, antenna and posterior leg of male; c and d, ventral view of abdomen of male and female.



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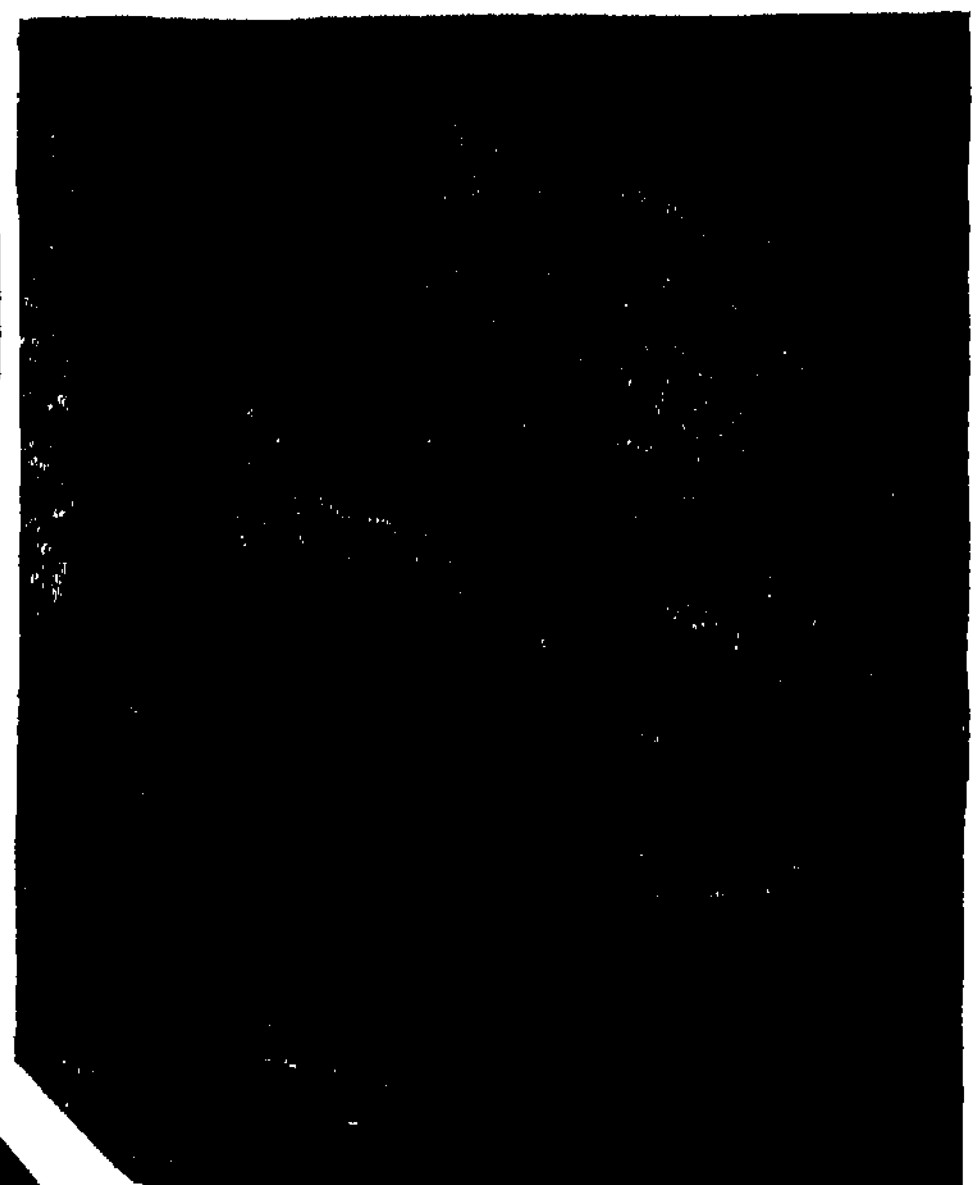

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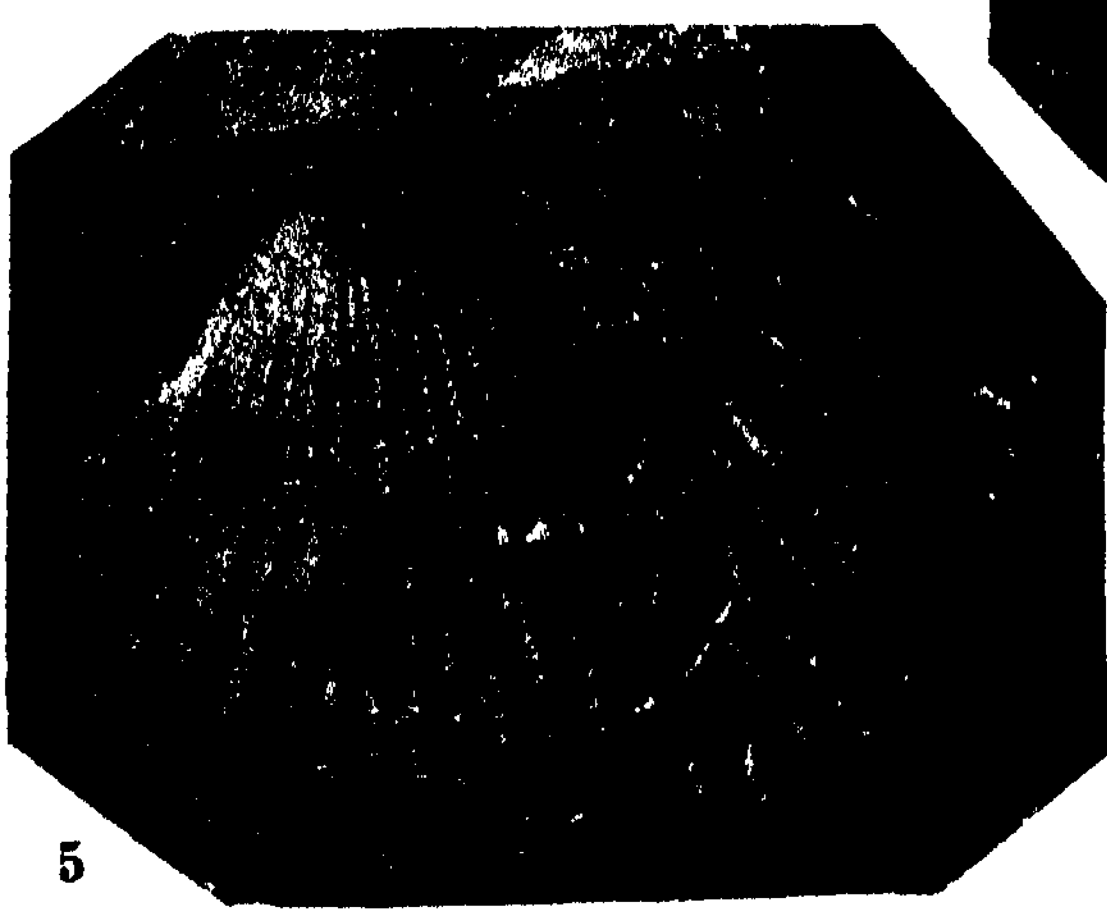

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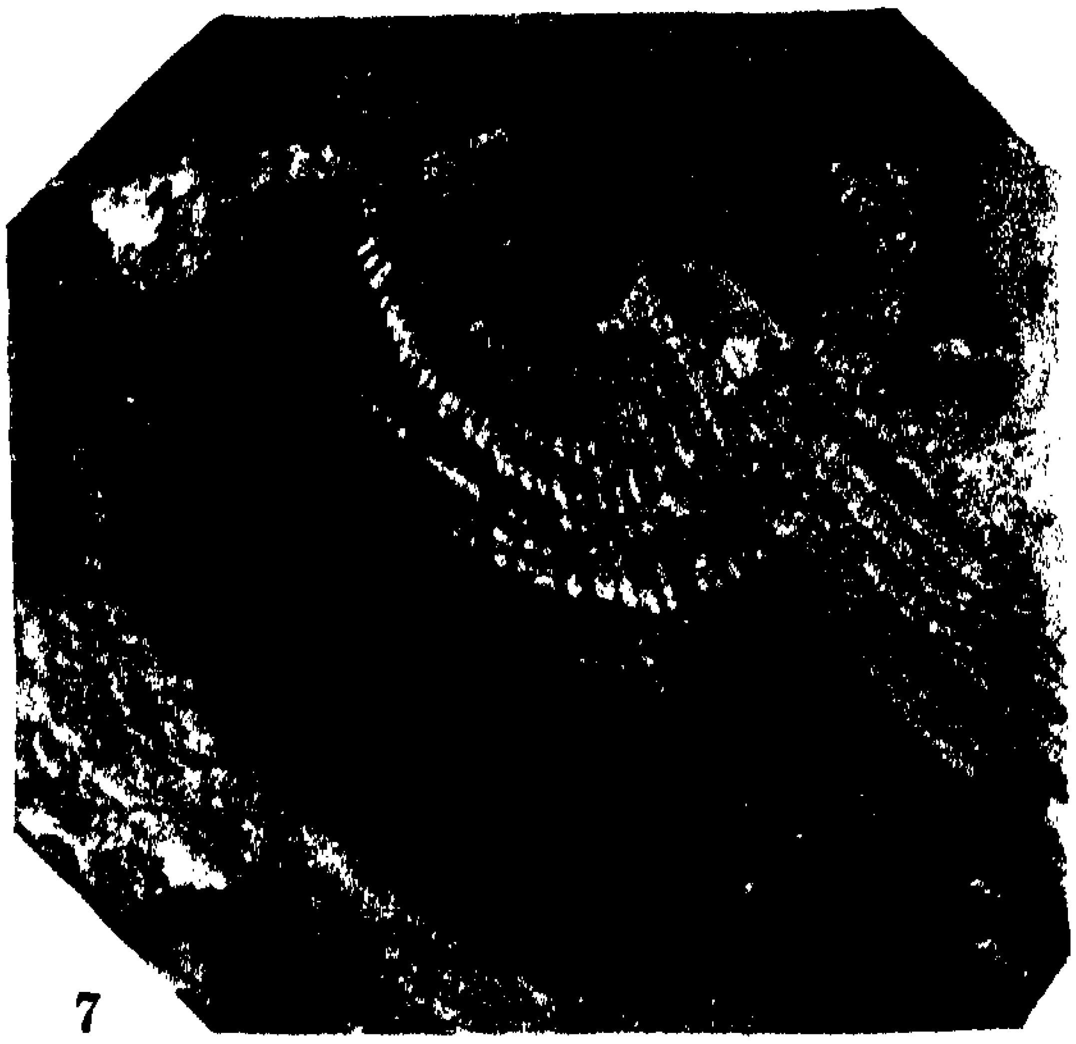
6

Aviculopectens from the Carboniferous of New South Wales

J. M. photo.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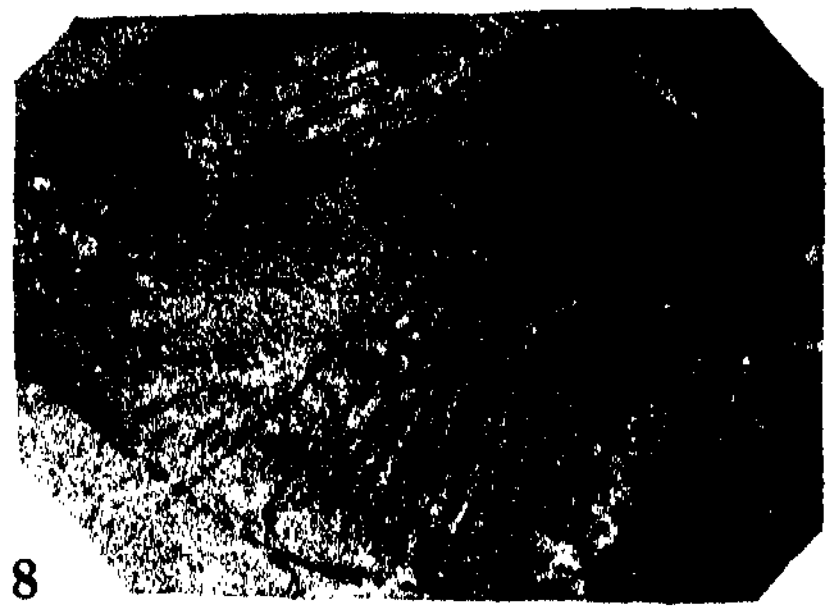
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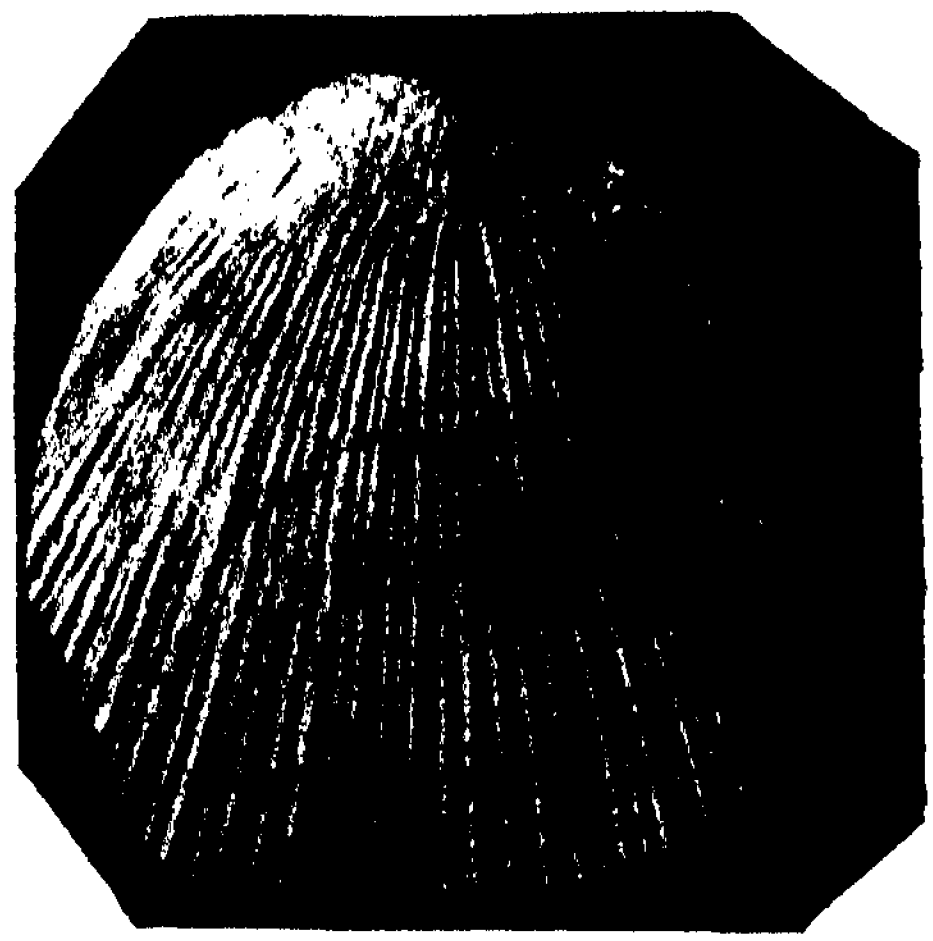
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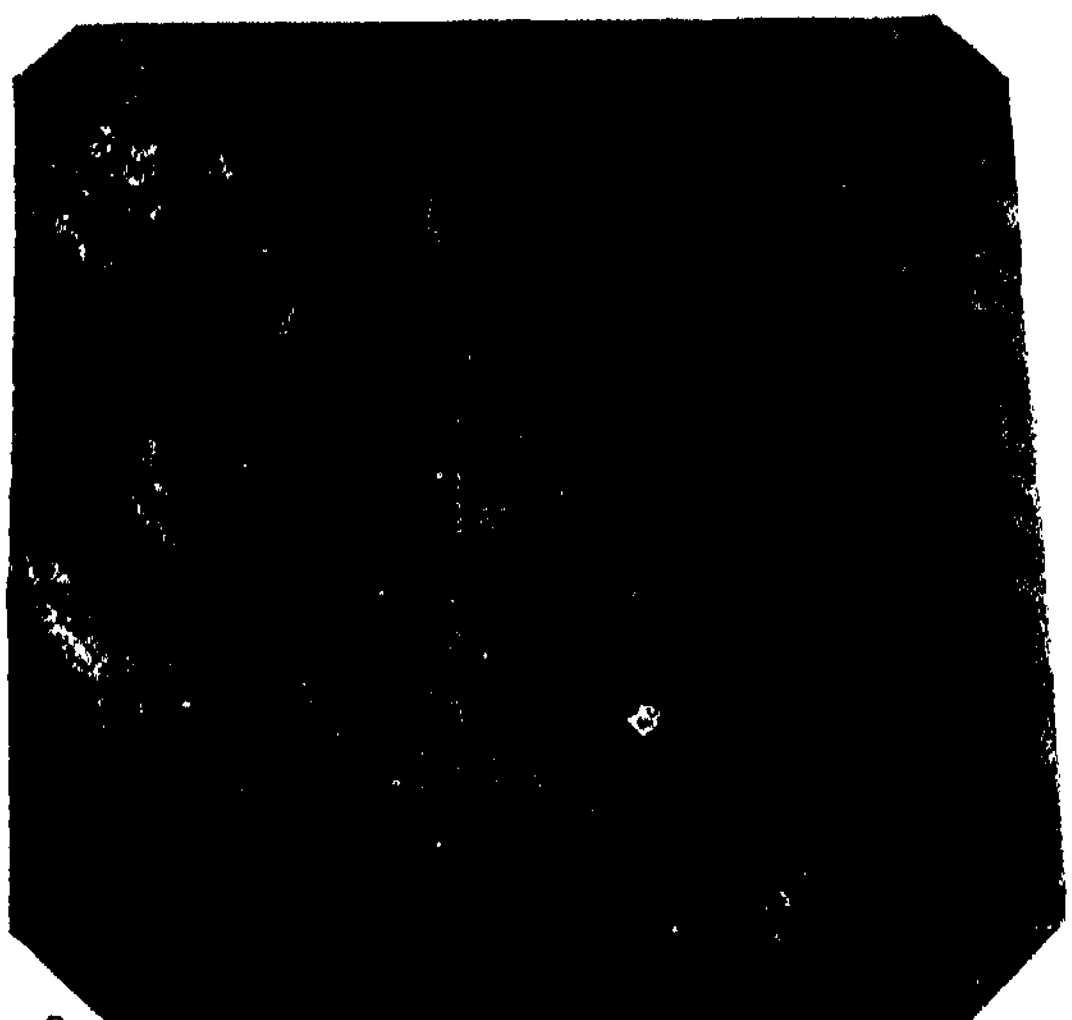
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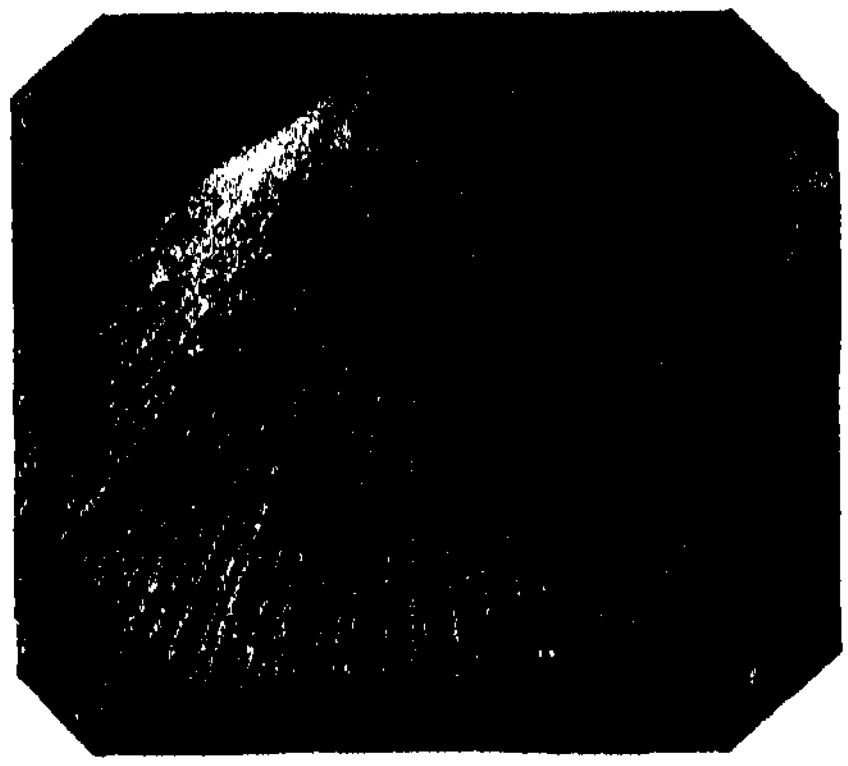
Aviculopectens from the Carboniferous of New South Wales.
Photo by H. G. Gooch and J. M.

13



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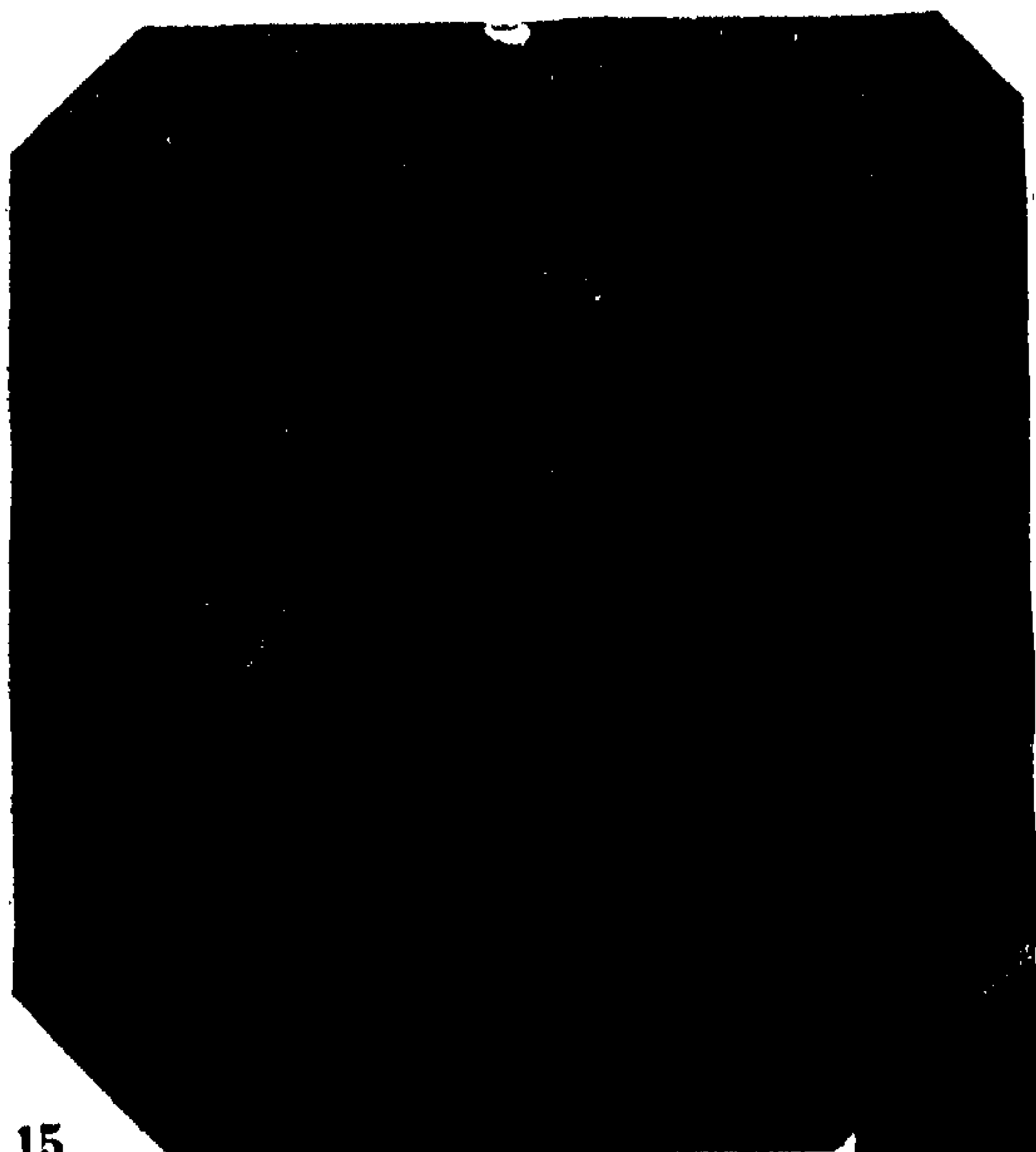

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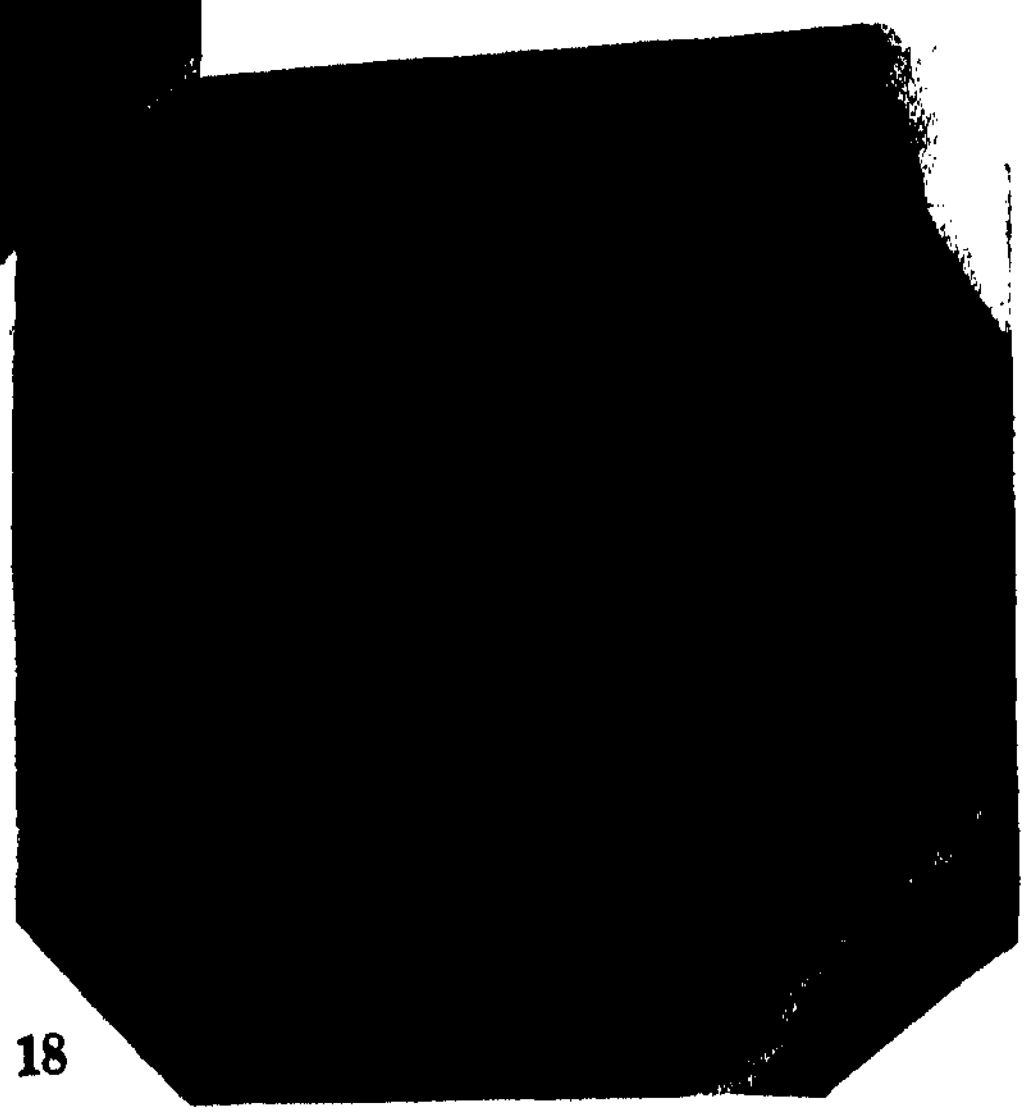
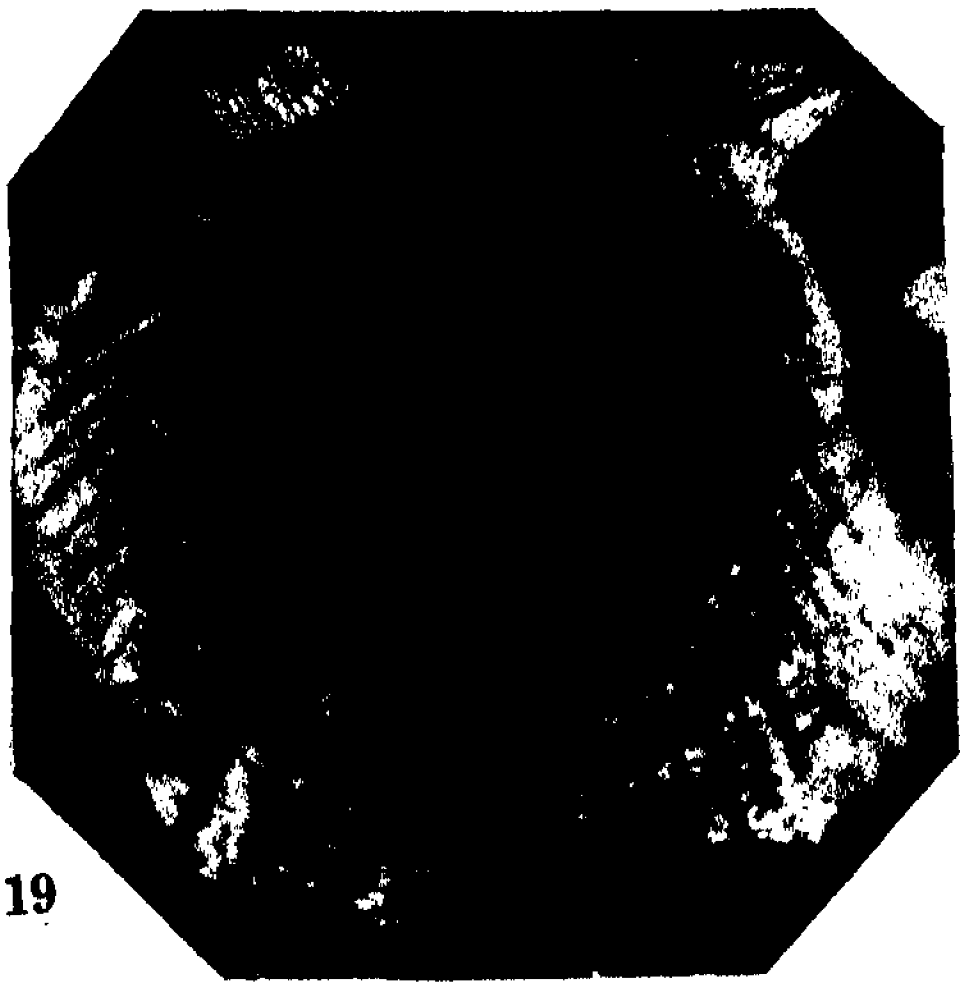


18

Aviculopectens from the Carboniferous of New South Wales.

Photo by H. G. Gooch and J. M.



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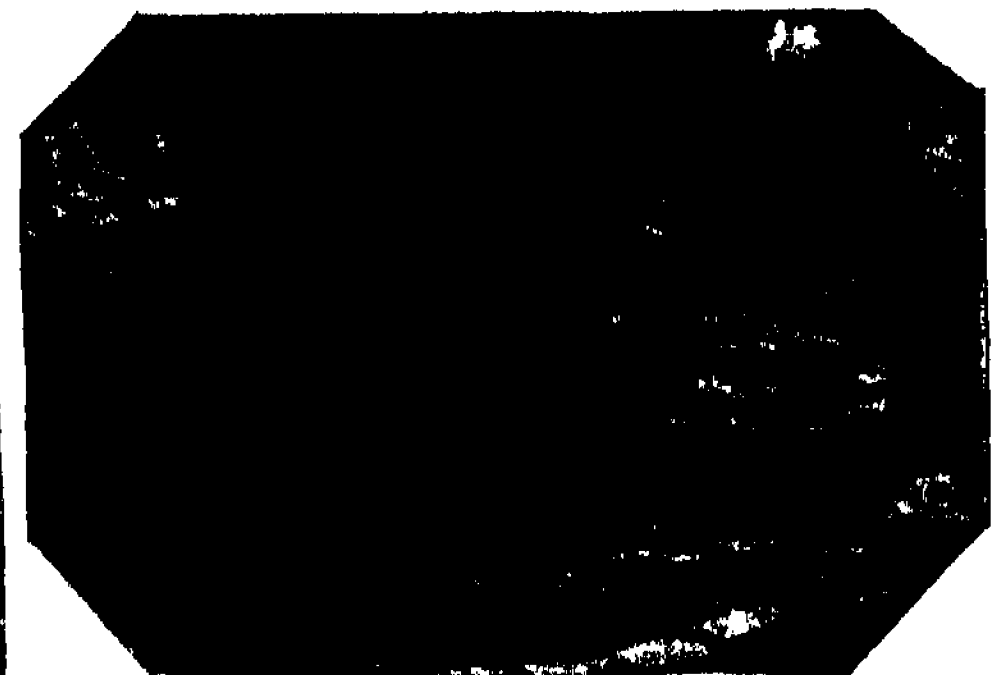

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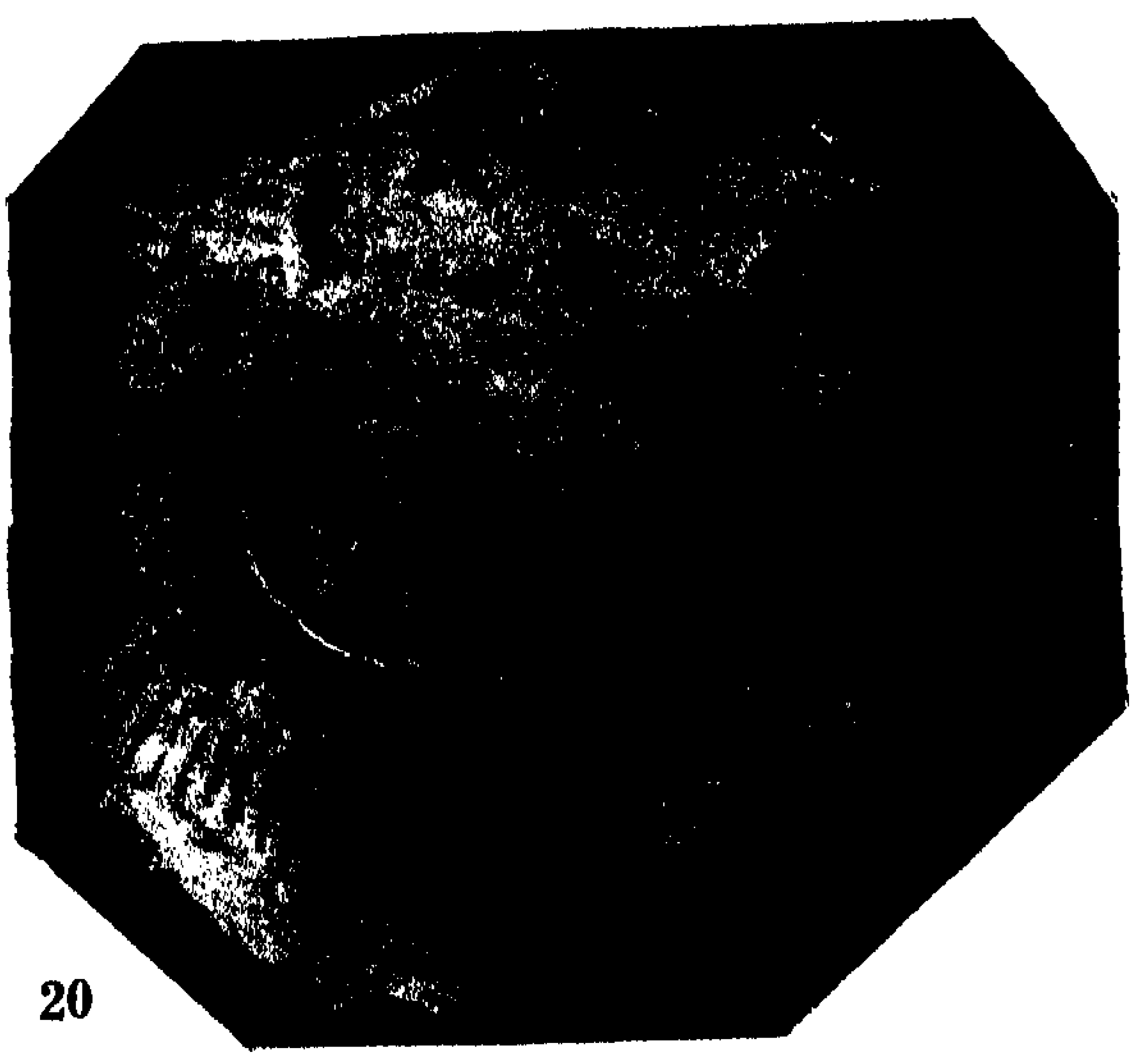

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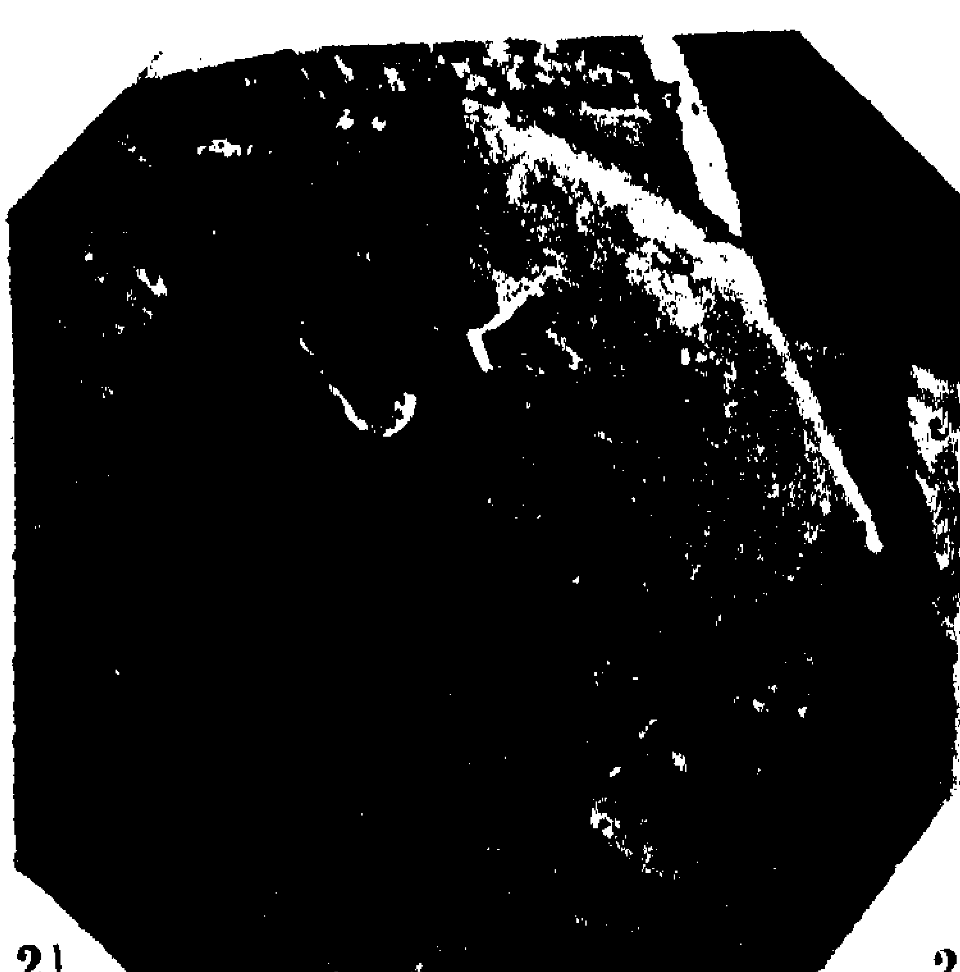

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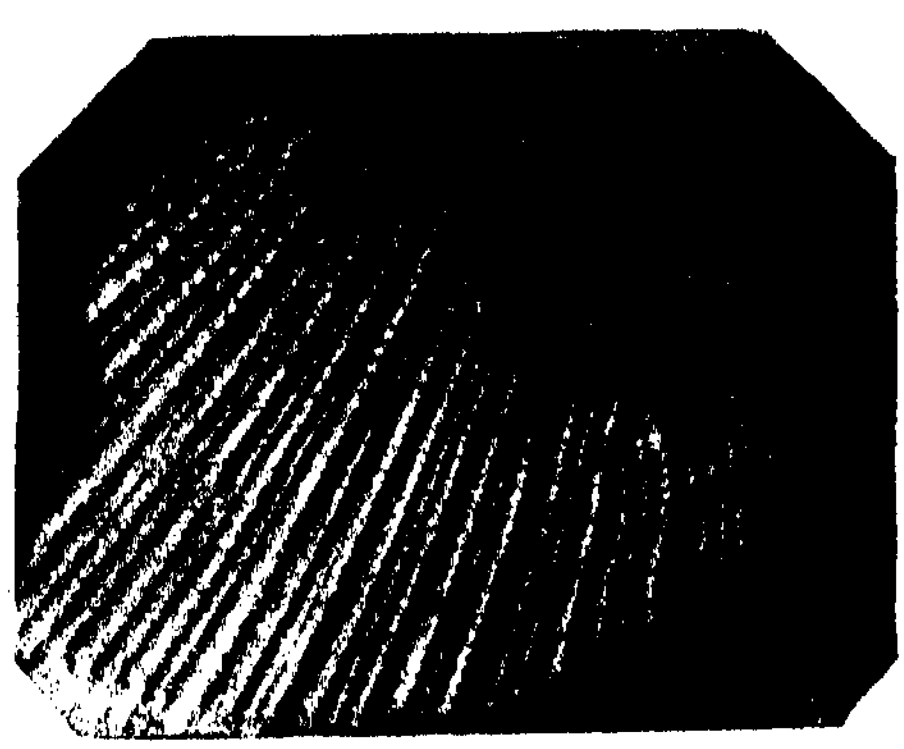
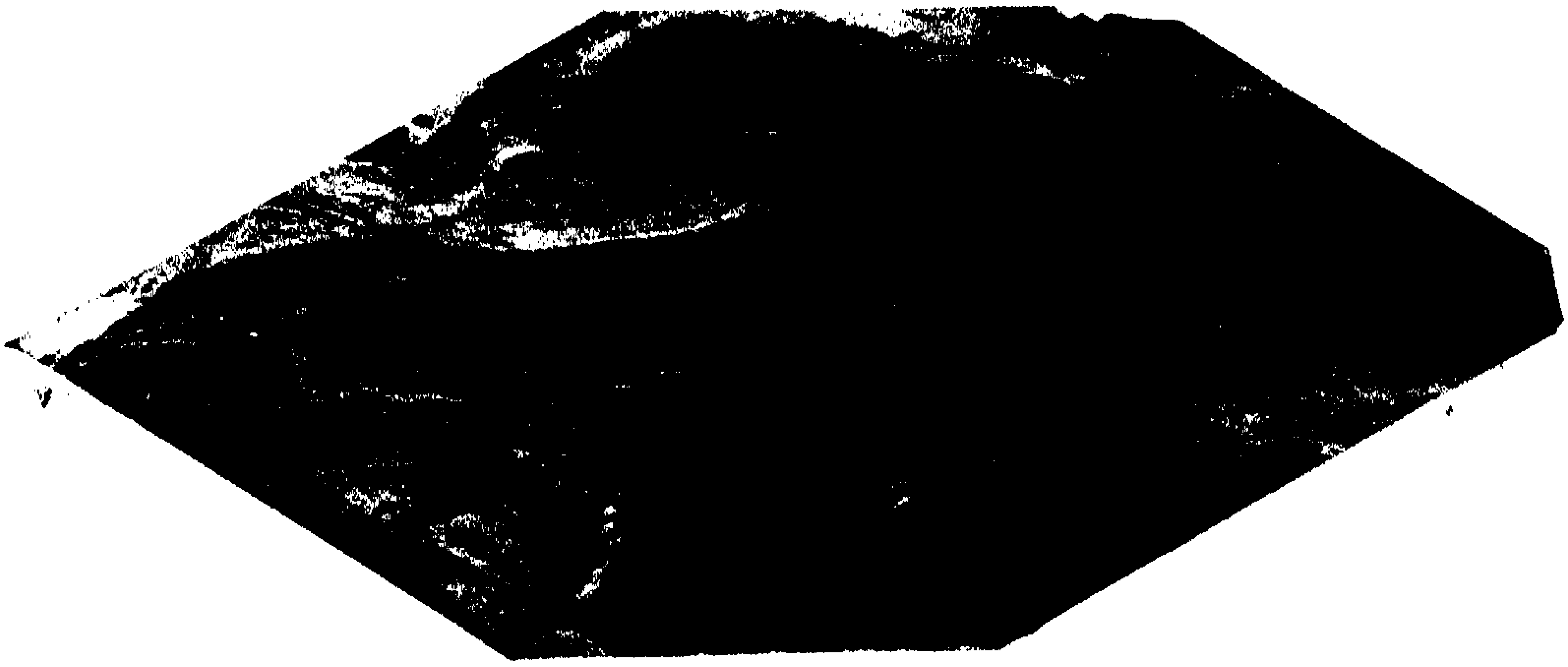


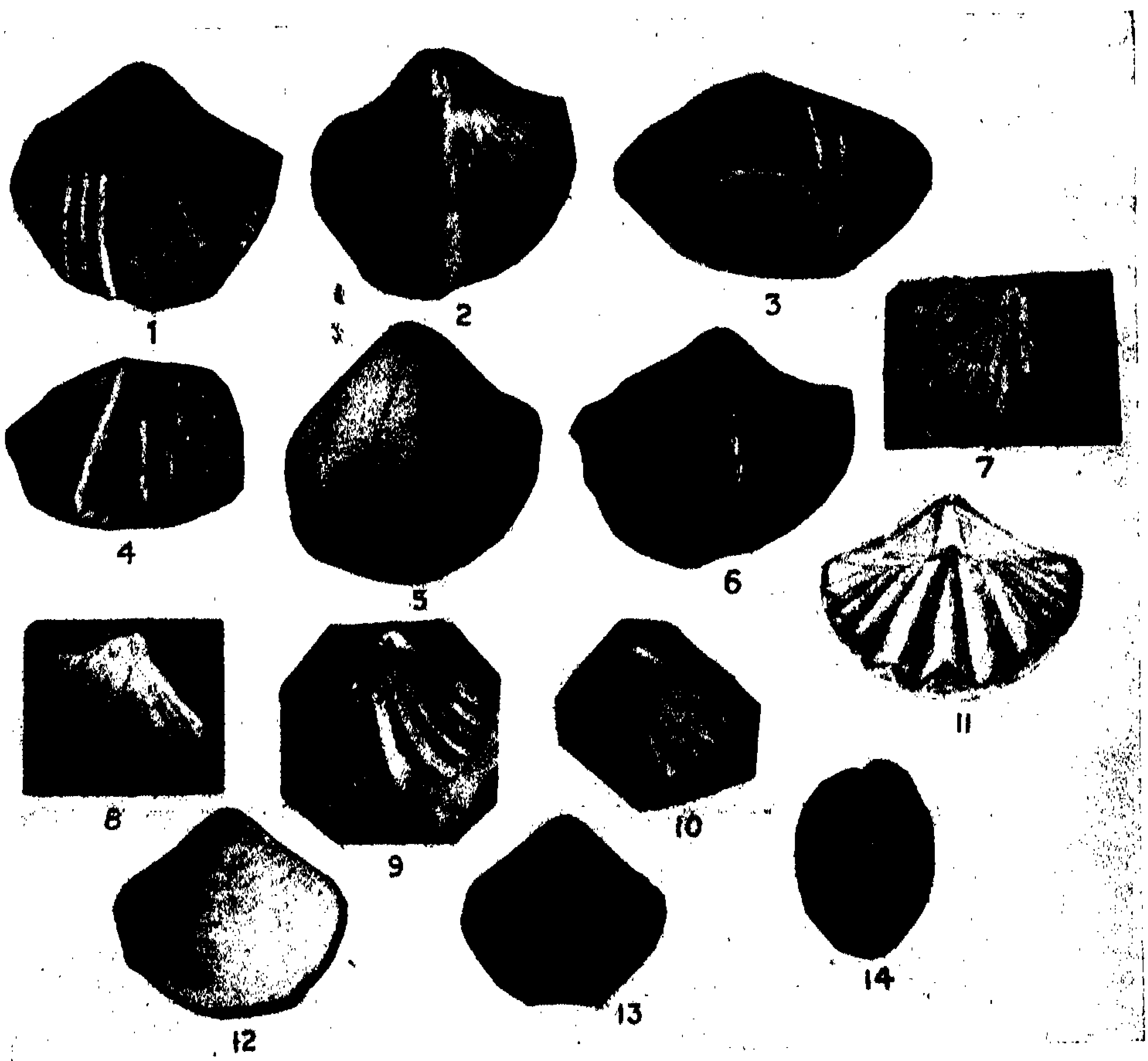
22

Aviculopectens from the Carboniferous of New South Wales.

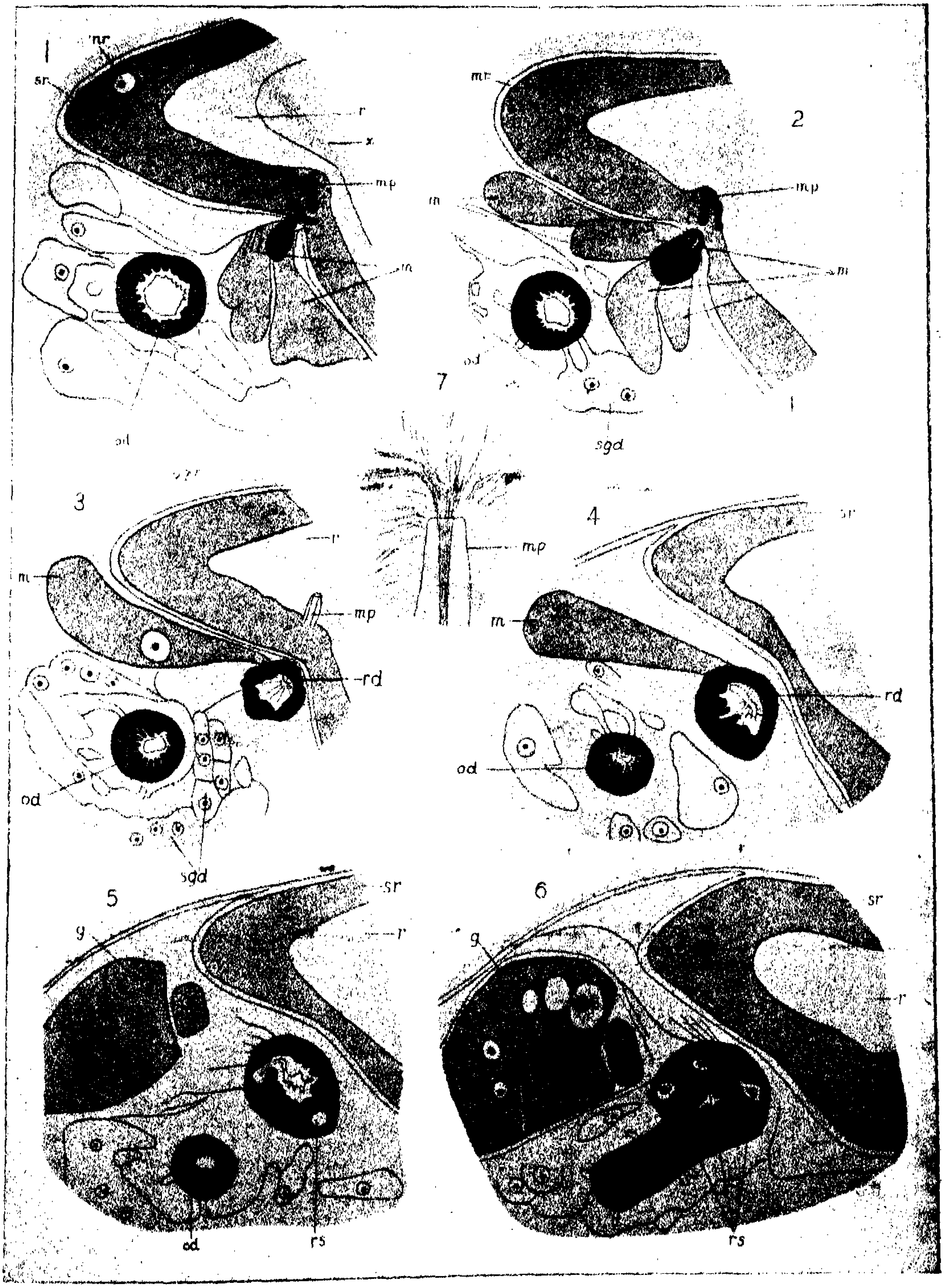
J. M. photo.



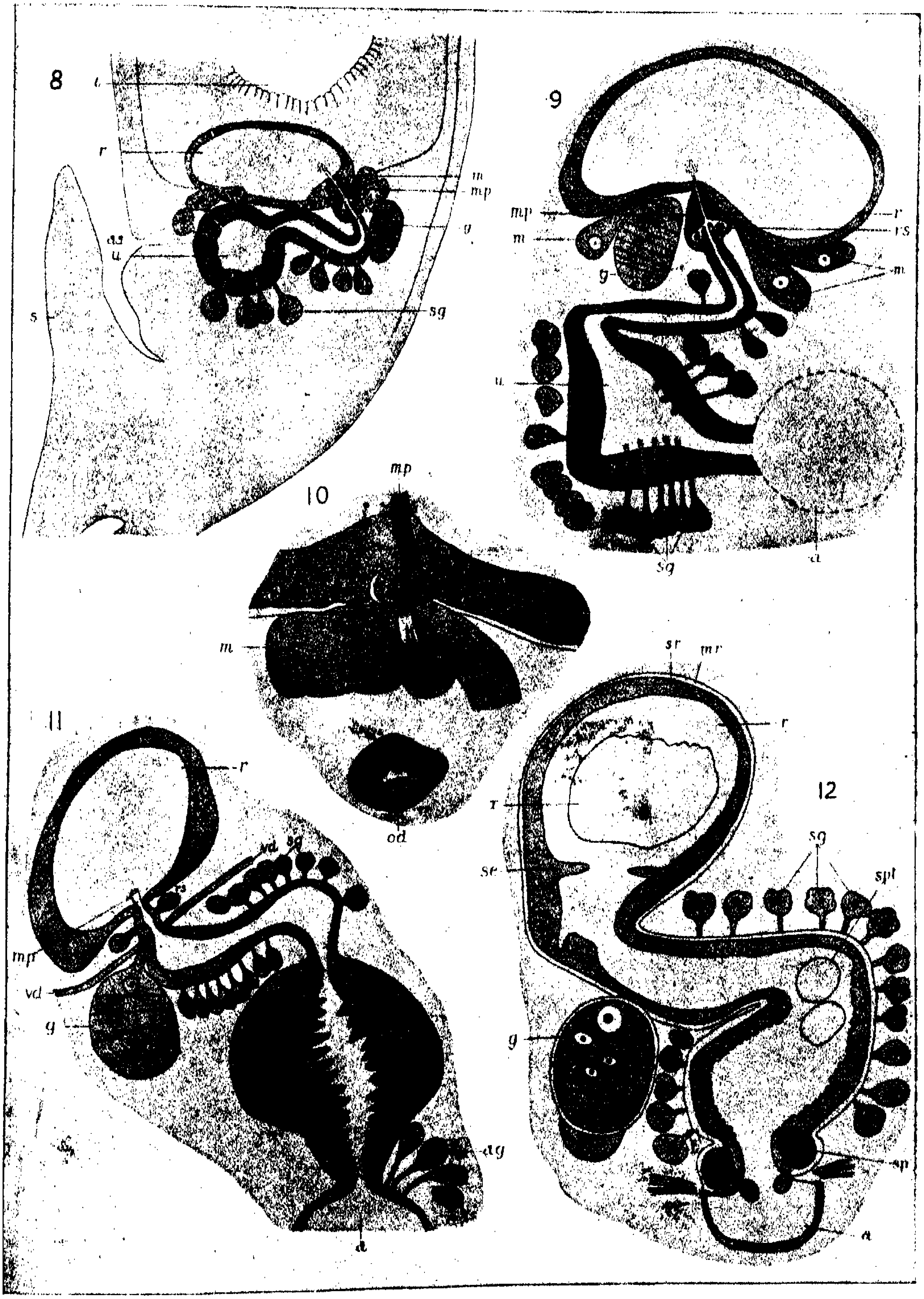
A. *Elonichthys davidi*, n.sp.



Middle Devonian Brachiopods from New South Wales.

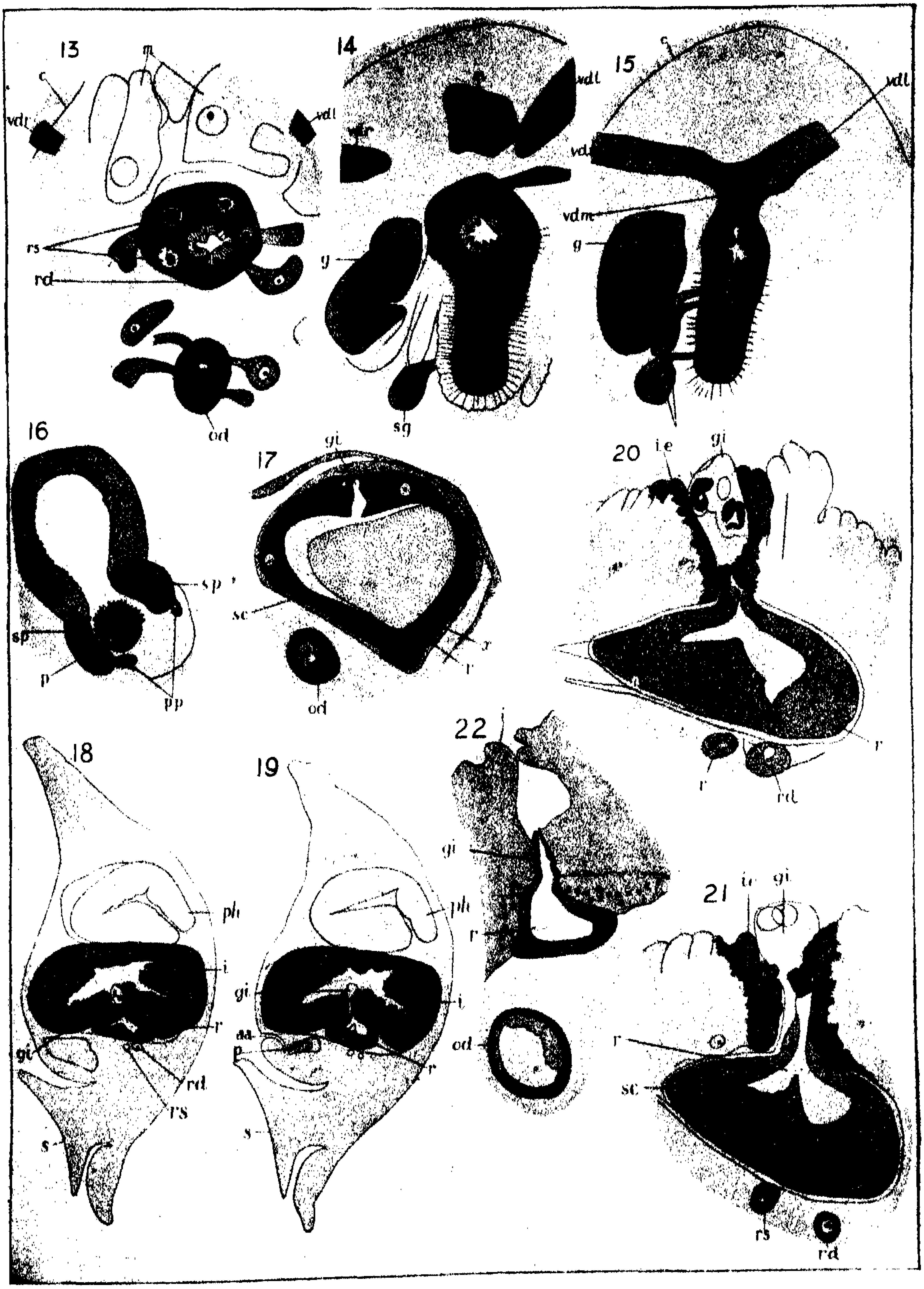


W. A. H. del. *Temnocephala fasciata.*



W. A. H. del.

8-10. *Temnocephala fasciata.* 11. *T. novae-zelandiae.* 12. *T. comes.*



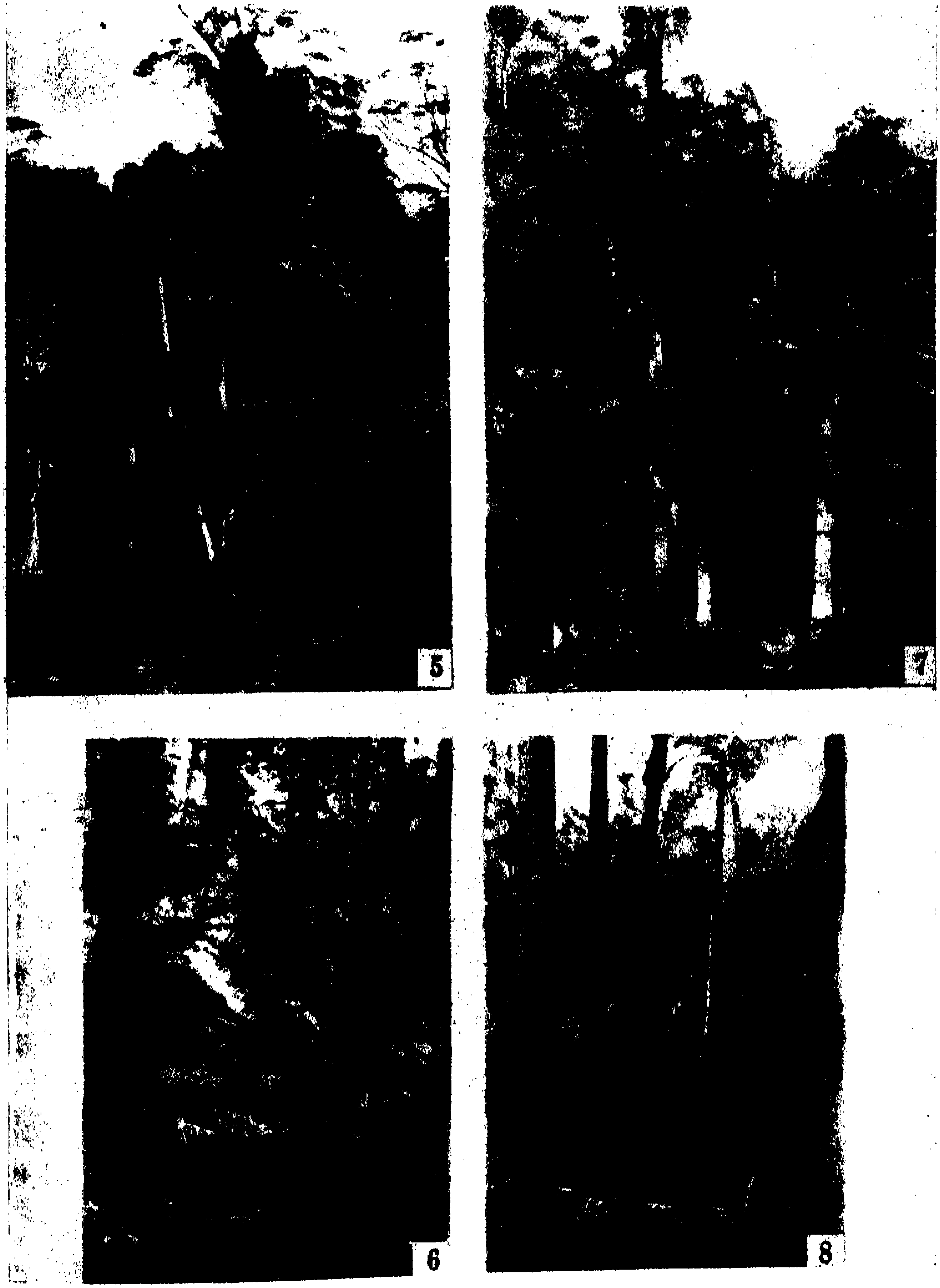
W. A. H. del.

13-15, 17. *Temnocephala fasciata.* 16. *T. comes.*
18-21. *T. tasmanica.* 22. *T. quadricornis.*

Map of the Mount Wilson Region.
The diagonal hatching indicates the basalt caps.
(From the 16-mile map issued by the Geological Survey of New South Wales.)

Ceratopetalum-Doryphora Forest in the Mt. Wilson region.

1. Showing *Dicksonia, Alsophila* and *Blechnum discolor.*
2. Showing bare ground under canopy of a large *Ceratopetalum.*
3. *Tmesipteris tannensis* growing from a sloping *Dicksonia* trunk.
4. *Dicksonia.*



5, 6. Ceratopetalum-Doryphora Forest. 7. Eucalyptus-Doryphora Forest.
8. Eucalyptus-Alsophila Forest.

9. Junction of Eucalyptus-Alsophila Association and Eucalyptus-Pteridium Association.

10. Interior of Ceratopetalum-Doryphora Forest.